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Mohamed Mannaa
Department of Ophthalmology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt, omarophth2000@gmail.com

Adel Osman
Department of Ophthalmology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt, dradelosman1952@yahoo.com

Ehab Elsheikh
Department of Ophthalmology, Faculty of Medicine, Al-Azhar University (Cairo),Egypt, ehabelshikh02@gmail.com

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Efficacy and Safety of YAG Laser Vitreolysis for Symptomatic Vitreous Floaters

Mohamed Mohamed Saad Mannaa [1]*M.Sc; Adel Abdel-Rahman Osman [1]MD and Ehab Abdel-Samei El-sheikh [1]MD.

**Corresponding Author:*

Mohamed Mohamed Saad Mannaa

Omarophth2000@gmail.com

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[1]Ophthalmology Department, Faculty of Medicine, Al-Azhar University, Cairo , Egypt

ABSTRACT

Background: The symptoms of patients with vitreous floaters are frequently underestimated, leading to no intervention. The majority of patients who have floaters receive conservative therapy that includes patient education and reassurance. On the other hand, more severe instances can necessitate pars plana vitrectomy or YAG laser vitreolysis. The potential for conducting vitreolysis using an Nd: YAG laser has arisen as an alternate therapy to avoid the complications of vitrectomy.

Aim of The Work: To evaluate the safety and effectiveness profile of YAG laser vitreolysis as a modality of therapy for symptomatic vitreous floaters.

Patients and Methods: A prospective study has been done on 50 eyes of 50 patients who had full posterior vitreous detachment and persistent vitreous floaters. The Ultra Q ReflexTM (Ellex Medical Lasers, Adelaide, Australia) was used to perform laser vitreolysis on patients. Follow-up was done for 6 months. Patient satisfaction and complications were recorded.

Results: 6% of patients experienced treatment failure, compared to 14% of patients who reported complete success, 46% who reported significant success, and 34% who reported partial success. No complications were recorded in postoperative 6 months follow up period.

Conclusion: When used on carefully selected patients, YAG laser vitreolysis represents a safe and efficient therapy for symptomatic vitreous floaters.

Keywords: *Vitreous Floaters; Weiss Ring; Nd:YAG Vitreolysis; Posterior Vitreous Detachment.*

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INTRODUCTION

Vitreous is an extraordinary extracellular matrix containing 98% water. Only 2% of the vitreous is composed of macromolecules, despite that, these molecules are critical to the vitreous' gel state, transparency, and physiological function (s) in the eye. [1]

By maintaining collagen fibrils separate, hyaluronan preserves vitreous transparency in youth. Over time, hyaluronan separates from collagen, inducing cross-linking and collagen aggregation with fibrous structures that scatter light. [2]

The association between collagen and hyaluronan is changed by myopia and ageing, resulting in concurrent gel liquefaction and fibrous degeneration. The most prevalent reasons for the vitreous floaters visual phenomenon are vitreous opacification and vitreous body collapse, which occur during posterior vitreous detachment (PVD). [3]

It ranks among the most common complaints made to ophthalmologists. [4] The majority of patients could tolerate their symptoms, but a significant minority consider floaters to be bothersome. Floaters are particularly problematic for myopes, pseudophakes, and individuals whose jobs demand precision detail work. [5]

Vitreous floaters could be extremely annoying, interfere with perceptions and day-to-day visual comfort, and cause a person to become physically and psychologically exhausted. [4] Previously, these vitreous opacities were thought to be innocious, but occasionally they can impair vision, make difficulity to read or drive, and generally have a negative influence on quality of life. [3]

According to a utility analysis, patients having symptomatic floaters became willing to take a 7% risk of blindness and an 11% risk of mortality to get rid of the symptoms. Floaters had utility values that were equivalent to those of ARMD and comparable to those of glaucoma, mild angina, strokes, and asymptomatic HIV. [6]

The medical community has up until now largely neglected the suffering of people having vision-degrading myodesopsia, perhaps as a result of floaters' ubiquity. Better disease staging and more precise detection of severe cases that require treatment were made possible by improved diagnostics.[1]

Until recently, patients with annoying floaters had just two choices: either learn to bear with them or have a vitrectomy. PPV effectively eliminates the symptoms linked to floaters, but it is an extremely invasive operation with a high risk of complications.[5]

A lot of attention has been paid to the usage of the YAG laser for vitreolysis in recent years for the therapy of bothersome vitreous floaters.[7]

Laser vitreolysis works by photodisrupting vitreous aggregates, which reduces opacity and shifts them off the optical axis.[4]

The publication of studies with contradictory findings and possibly sight-threatening consequences, however, has stoked controversy and might have prevented the technique from being widely used. As a result, the technique is still highly contentious.[7]

The study aimed to evaluate the safety and effectiveness profile of YAG laser vitreolysis as a modality of therapy for symptomatic vitreous floaters.

PATIENTS AND METHODS

Fifty eyes from fifty patients having symptomatic vitreous floaters were selected from Al-Azhar University Hospitals' outpatient ophthalmology clinics (Al Hussein and Sayed Galal). This non-randomized prospective study took place between January 2019 and February 2022.

Inclusion criteria: Symptomatic floaters (a self-rated visual disturbance that is at least assessed as 4 on a 0–10 scale (0 = no symptoms, 10 = debilitating symptoms), symptoms duration of at least 3 months and stable, absence of flashes of light suggesting an incomplete PVD, vitreous opacities that are at least 3 mm from the retina and 4 mm away from the crystalline lens's posterior lens capsule, as assessed on a B-scan, and PVD that is confirmed by a clinical evaluation, a B-scan, and an Optical Coherence Tomography.

Exclusion criteria: Snellen best-corrected visual acuity (BCVA) less than 20/40 in the other eye, history of retinal tear or detachment, active retinal pathology such as diabetic retinopathy, uveitis, aphakia in the studied eye, and history of glaucoma or high eye pressure.

Ethical consideration:

The protocol was submitted for the Research Ethics Committee's approval. All patients received a complete explanation of the procedure with its own benefits and possible complications. According to the Medical Ethics Committee of the Faculty of Medicine at Al-Azhar University, informed written agreement has been obtained from all patients prior to the initiation of the procedure.

Preoperative Evaluation

Detailed history taking including: Age, gender, past or present eye problems, history of cataract or refractive surgery, history of elevated IOP, glaucoma drops, history of intraocular inflammation, retinal tear and detachment. A family history of RD or hereditary conditions affecting collagen such as Stickler or Marfan syndrome, history of psychiatric problems. Floater history: for how long the patient had these symptoms? presence of flashes of light, number of the floaters, how do these floaters look like? Cob webs or flying particles? severity of symptoms, on 0-10- point scale and in what activities does the floater bother the patient.

Examination of the eyes including: Best corrected visual acuity (BCVA) and refraction. Examination of the anterior segment and measurement of IOP with a Goldmann applanation tonometer. Fundus examination using the indirect ophthalmoscope with Volk 20 diopters lens and scleral depression and fundus biomicroscopy with a non-contact lens (Volk 90 diopters lens), presence or absence of PVD, morphology of the floaters: The floaters or vitreous opacities correlated with the patient's symptoms.

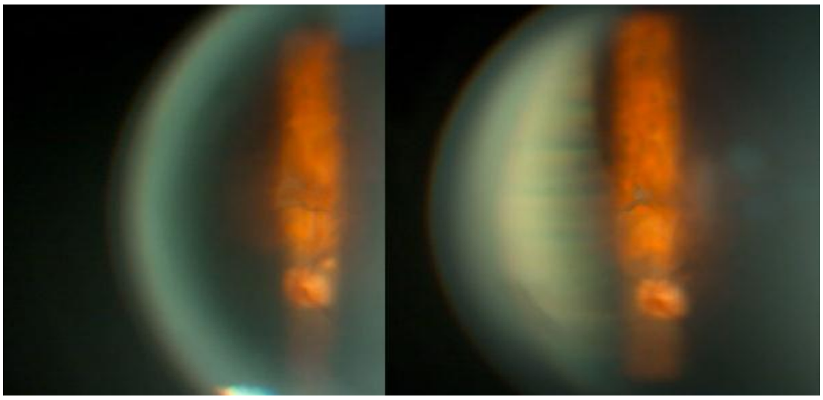

Figure (1): fundus photo shows Weiss ring opacity (patient no. 20)

B-scan US: using Scanmate Flex B-scan (DGH Technology, Inc. USA): For detection of PVD, measure the locations of the opacities from the retina.

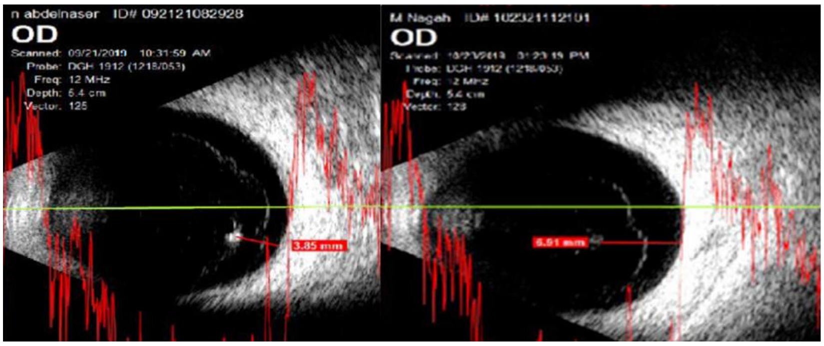

Figure (2): B scans of patients no. (7 and 9).

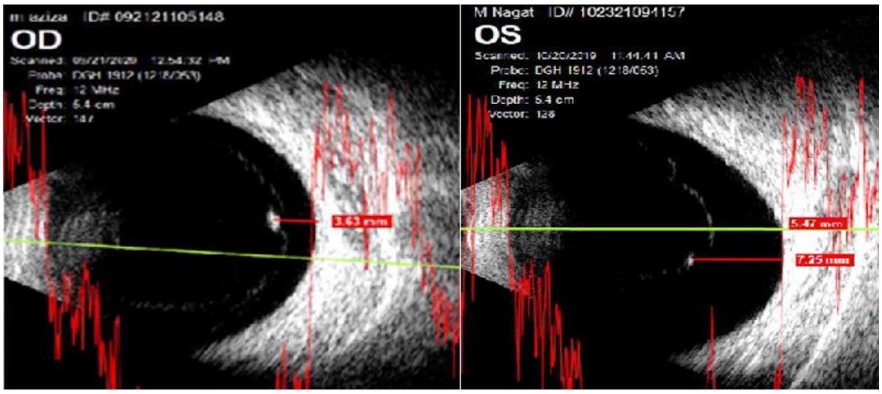

Figure (3): B scans of patients no. (18 and 35).

Optical coherence tomography (OCT): macular morphology, central subfield thickness, and existence of PVD utilizing the DRI Triton plus OCT system (Topcon Co., Japan).

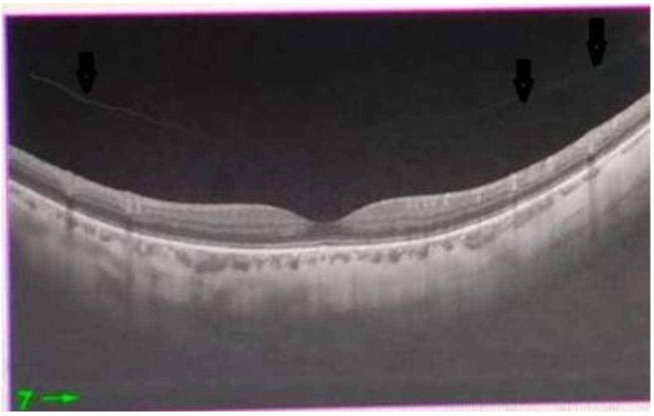

Figure (4): OCT scan of patient no. 15 shows complete PVD.

YAG vitreolysis procedure: The procedure done using Ultra Q Reflex™ (Ellex Medical Lasers, Adelaide, Australia).

The pupil was dilated with tropicamide 1% and phenylephrine 2.5%. Topical anesthetic with benoxinate 0.4%. Ocular Karickhoff 21 mm Vitreous Lens for floaters in the optic axis centre and Ocular Karickhoff Off-Axis Vitreous Lens for floaters off the optic axis. The initial energy setting was 2.5 mJ with a single pulse per shot. The laser energy was titrated to a suitable level, where plasma formation with gas bubble formation was observed. The laser shots given per patient will be ceased after vaporization of the visually significant floaters or a maximum of 500 shot per treatment session. Other treatment sessions was considered after 2 weeks if there were more residual floaters and the symptoms were still present.

Follow up: On the first postsurgical day, the first week, the first month, the third month, and the sixth month, all patients underwent repeated assessment with BCVA, IOP by applanation tonometry, slit-lamp examination, and indirect ophthalmoscopy with scleral depression. Patients have been questioned about their floater symptoms compared to before the laser procedure and asked to rate their post-operative improvement as one of the following at each follow-up visit: (a) Failure: floaters are the same or worse. (b) Partial success: There has been some improvement, but there are still some moderate annoyances. (c) Significant success: substantial improvement with minor inconvenience. (d) Complete success: all floaters have been resolved. Any developed complications were assessed and managed.

Outcome measure: subjective change in floater symptoms. The incidence of complications leading to alterations in the eye's structure or reduced vision both immediately following therapy and up to 6 months post-interventional. Changes in BCVA and IOP following the laser procedure.

Statistical analysis: Version 8 of GraphPad Prism was utilised to conduct the statistical analysis. The BCVA and IOP were compared pre and post therapy using the Wilcoxon matched pairs signed rank test. Statistical significance was defined as p-values less than 0.05.

RESULTS

This study was performed on fifty eyes of fifty patients. All of them had symptomatic vitreous floaters with established PVD and underwent YAG laser vitreolysis.

		Number of eyes n=50
Age	Range	38 – 68
	Mean ± SD	58 ± 6.8
Sex	Males	12 (24%)
	Females	38 (76%)
Affected Eye	Right	27 (54%)
	Left	23 (46%)

Table (1): Demographic characteristics of the studied patients

The patients' ages varied from 38 to 68 years, with an average age (±SD) of 58 ± 6.8 years. Thirty-eight patients (76%) were women, and twelve patients (24%) were men. The right eye was impacted in 27 cases (54%), whereas the left eye was affected in 23 cases (46%) (Table 1).

Pt No.	Duration of symptoms (months)	Severity of symptoms (on 0-10 scale)	Activities most affected by floaters
n = 50	(3 -18) 6.5 ± 3	(5-9) 7.1 ± 0.8	Near activities 18 (36%) Distant activities 11(22%) All of the time 21(42%)

Table (2): characteristics of floaters

The duration of floaters symptoms ranged from 3 months to 18 months with the mean of 6.5. The severity of symptoms on (0-10) scale ranged from 5 to 9 (7.1 ± 0.8). 18 patients (36%) were affected more when they were performing near tasks like reading, 11 patients (22%) were affected more in distant vision like driving while the remaining 21 patients (42%) were annoyed by their floaters all of the time (Table 2).

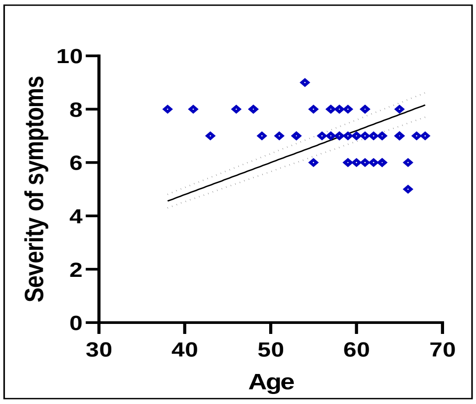

Figure (5): correlation between the patient age and severity of symptoms.

The patient's age and the severity of their symptoms had a significant negative association, p = 0.0015** (Figure 5).

Ocular condition	Number of eyes (n=50)
Cataract surgery	27 (54%)
Myopic lasik	3 (6%)
Hyperopic lasik	1 (2%)
(RLE) for high myopia	1 (2%)

Table (3): previous ocular conditions in the treated eyes.

27 (54%) patients had previous cataract surgery. 4 (8%) patients underwent LASIK surgery, 3 (6%) for myopia and 1 (2%) for Hyperopia. 1 (2%) patient had refractive lens exchange (RLE) for high myopia. 18 (36%) patients had unremarkable ophthalmic history (Table 3).

Ametropia	Number of eyes (n = 50)
Myopia	24 (48%)
Hypermetropia	18 (36%)
Emmetropia	8 (16%)

Table (4): Descriptive analysis of the studied patients according to ametropia.

Of the 50 patients of this study, 3 patients were high myopes with a refraction spherical equivalent ≥ -6 diopters, 21 patients were low to moderate myopes with a spherical equivalent < 6 diopters, while 18 patients were hypermetropes, and 8 patients were emmetropes (Table 4).

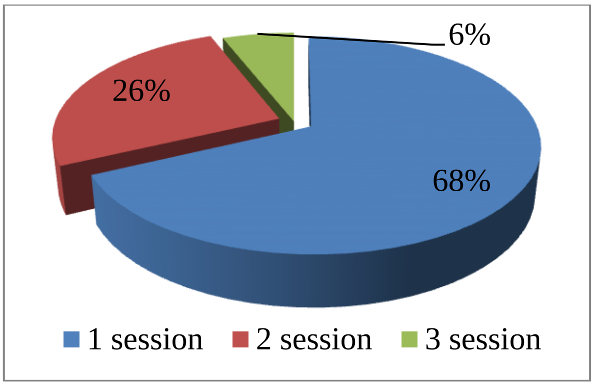

Figure (6): The pie chart shows the total number of sessions required for vitreolysis completion.

Targeted floaters were classified into; Weiss ring floaters (27(54%) patients) and mid-vitreal opacity (23(46%) patients).

The number of sessions varied between one and three. A single therapy session was necessary for 34 cases, two sessions for 13 cases, and three sessions for the remaining three patients (Figure 6).

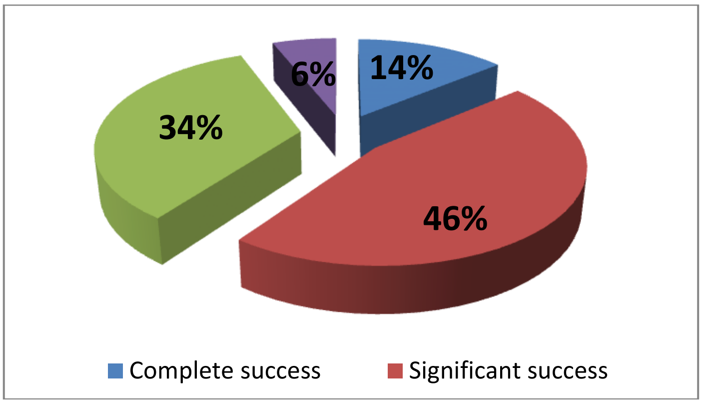

Figure (7): Patient satisfaction level.

The YAG laser's energy levels used for vitreolysis varied from 2.8–6.3 mJ, with the mean energy being 4.6 mJ.

Regarding patient satisfaction following YAG laser vitreolysis, 14% of patients reported complete success, 46% of patients reported significant success, 34% of patients reported partial success whereas 6% of the patients reported failure of the treatment (Figure 7).

When comparing the satisfaction level between patients with Weiss ring opacities vs those with mid-vitreal opacitie, we found that: patients with weiss ring opacities showed ; 25.9% complete success, 51.9% significant success, 18.5% partial success and 3.7% failure. Whereas patients with mid-vitreal opacities showed 39.1% significant success, 52.2% partial success and 8.7% failure of the treatment (Table 5).

Patient satisfaction level	Weiss ring n=27	mid-vitreal n=23
Complete success	7 (25.9%)	0(0%)
Significant success	14 (51.9%)	9 (39.1%)
Partial success	5 (18.5%)	12 (52.2%)
Failure	1 (3.7%)	2 (8.7%)

Table (5): Patient satisfaction level in patients with weiss ring opacities vs mid-vitreal opacitie

IOP and BCVA (Log MAR) did not statistically differ before or up to six months following therapy (Table 6).

	Pre op BCVA	Post op BCVA	P. value
Mean ± SD	0.71 ± 0.17	0.72±0.18	0.06
	pre-operative IOP	post-operative IOP	P. value
Mean ± SD	14 ± 2.7	14 ± 2.4	0.72

Table (6): The difference between BCVA (Log MAR) and IOP before and after surgery.

No complications occurred during the procedure or recorded in postoperative 6 months follow up period.

DISCUSSION

This study proved that YAG laser treatment is beneficial for getting rid of annoying floaters and resulted in high patient satisfaction with no complications up to 6 months post-treatment.

The patients' ages varied from 38 to 68 years, with an average (±SD) age of 58 ± 6.8 years. Thirty-eight patients (76%) were women, and twelve patients (24%) were men.

This is in agreement with Lin et al., [8], where there was a clear female predominance (72.55%) with a mean age of 56.80 ± 10.82 (range 24–76) years for all participants (51 patients). In another study by Ludwig et al., [9] conducted on 24 patients, the patients' ages ranged from 48 to 83, with a mean age of 62 ± 7.9 years. The majority of the patients examined were women (76.2%).

Tsai et al., [10] included 15 patients in the study. Six of the patients out of the 15 were men, and nine were women. Their average age was 56.93 years, and their ages varied from 42 to 70.

Any procedure's success is dependent on its safety, efficiency, and ease. 94% of the studied patients benefited from the procedure. 60% of patients reported complete and significant success. 34% of patients reported partial success, whereas 6% of the patients reported failure of the treatment.

The patients who had partial success believed that the moderate benefit gained was still sufficient to avoid the necessity for more surgery.

In 1993, the first study on YAG laser vitreolysis for floaters was released. Tsai and associates treated 15 individuals having prepapillary or central vitreal opacities using a YAG laser with energy levels of 5–10 mJ/burst. All of the patients (100%) expressed satisfaction with the therapy and noted that their floaters cleared, along with a marked reduction in anxiety. [10]

A single-center retrospective analysis was conducted by Delaney et al. [11] with 31 individuals (42 eyes) who had pars plana vitrectomy or YAG laser vitreolysis (maximal energy/burst: 1.2 mJ) for vitreous floaters. No case reported complete improvement, with the symptomatic alleviation after YAG laser therapy being classified as "moderate" (30–50% benefits) in 35.8% of patients and "significant" (50–70% benefits) in just 2.5% of patients.

The first randomised sham-controlled study assessing the efficacy and safety of YAG vitreolysis was carried out by Shah and Heier [12] in 52 eyes of 52 individuals (16 controls, 36 cases). Patients who underwent laser therapy said their symptoms were relieved more (54% versus 9%). Compared to none of the sham-treated controls, a total of 19 laser treatment patients (53%) reported a significant or full disappearance of symptoms.

In a study by Luo et al., [5], the findings of the patient satisfaction questionnaires revealed that 75% of patients reported "significant success," 25% reported "partial success," and 0% reported "failure" after YAG laser vitreolysis.

Sun et al., [13] evaluated the Nd:YAG laser's clinical effectiveness in the treatment of symptomatic floaters. The data indicated that significant and full resolution of vitreous floaters has been obtained in 63.64% of the examined eyes, as evaluated via objective quantification and in 56.37% of the eyes, as determined by self-reported data.

Fifty-one patients having symptomatic floaters have been managed with YAG laser vitreolysis in a single-center prospective trial. Participants have been split into two groups: those who have complete PVD and those who have not. Significant or full subjective enhancements were observed in the PVD and non-PVD groups, respectively, at 72.73% and 68.97%. [8]

The subjective improvements in YAG-treated eyes observed in the Delaney et al. [11] study was disappointing, with less patient satisfaction than recent studies. One of the reasons for the discrepancy may be related to the patient inclusion criteria: Shah and Heier, [12] only included individuals having a single Weiss ring, in contrast to Delaney et al., who included individuals having different forms of vitreous floaters. It is logical to presume that symptomatic relief is more likely to result from the removal of a single Weiss ring than from the therapy of many opacities. Another possibility would be the usage of low energy settings (maximum energy/burst: 1.2 mJ) by Delaney and his colleagues. Lower energy levels are expected to disrupt floaters but not totally eliminate them through vaporization, but higher energy levels may be capable of doing so using plasma-induced shock waves, thus leading to a less satisfactory outcome. [7]

Diverse patient selection criteria, the diversity of aimed floater morphology, as well as other parameters employed, may all contribute to the variation in patient satisfaction rates in several studies. More so than other floaters, Weiss rings target better outcomes and higher patient satisfaction ratings.

If the correct approach has been taken regarding diagnosis of a complete PVD, evaluation of floater morphology, distribution, and distance from the retina and crystalline lens, and employing acceptable therapy parameters, then most of the floaters could be vaporised by the Nd: YAG laser.

It's important to recognise that laser floater therapy is not meant to be a substitute for or a competitor to vitrectomy. In contrast to a vitrectomy patient, the ideal LFT patient is very different.[14]

The present study had a number of drawbacks, such as its small sample size, brief follow-up duration, and lack of a randomized control arm. However, the findings suggest that vitreous floaters can be treated safely and effectively with YAG laser vitreolysis.

CONCLUSION

This prospective study demonstrated that, in carefully selected patients, YAG laser vitreolysis was a safe and efficient for symptomatic vitreous floaters. Patients who have chronic Weiss rings reflect a patient group that might probably gain the most from such therapy.

Conflict of interest : none

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