· Clinical Research ·

Long-term efficacy and safety of YAG laser vitreolysis for vision degrading myodesopsia

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Abstract
● **AIM:** To assess the long-term efficacy and safety of yttrium-aluminum garnet (YAG) laser vitreolysis for vision degrading myodesopsia (VDM) caused by posterior vitreous detachment (PVD).
● **METHODS:** This retrospective study reviewed VDM patients of PVD type undergoing YAG laser vitreolysis. The baseline demographic information, the patterns of floaters, the number of floaters, and the subjective improvement of floater sympotoms (ranging from 0 to 100%) from medical records were collected. Significant improvement was defined as a relief of floater symptoms of ≥50% at the final visit. The long-term efficacy and safety of YAG laser vitreolysis were analyzed. The risk factors linked to significant improvement of floater symptoms were defined using univariate and multivariate logistic regression analyses.
● **RESULTS:** The final analysis included 221 patients with VDM. The mean age of patients was 61.08±7.74y, and the mean length of follow-up was 21.38±5.61mo. Totally 57.01% of patients experienced a significant improvement in their floater symptoms after YAG laser therapy, and none of them developed delayed retinal abnormalities such as retinal tears or detachments. Age (OR=1.049, 95%CI=1.007-1.092, *P*=0.021) was identified as a significant risk factor for significant improvement in VDM.
● **CONCLUSION:** YAG laser vitreolysis is an effective and secure treatment for PVD-type VDM, and patients of advanced age are more likely to get favorable outcomes.
● **KEYWORDS:** floaters; posterior vitreous detachment; YAG laser vitreolysis; risk factors; vision degrading myodesopsia
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INTRODUCTION

The vitreous gel within an infant's eye is a homogenous substance. The vitreous body gradually degrades and condenses as people age or become more myopic. At the same time, a cavity of collagen condensation and liquefaction forms, the collagen fibers in the vitreous body change and fuse, the vitreoretinal adhesion weakens, and the cortical vitreous separates from the retina, causing posterior vitreous detachment (PVD)[1]. PVD could occur 10–13y earlier in myopia[2]. Additionally, PVD progressed significantly faster in the eyes following cataract surgery[3].

During the vitreous liquefaction process, numerous vitreoretinal diseases, such as retinal tears, vitreomacular traction syndrome, epiretinal membrane, and macular hole, might occur. In addition, the large collagen polymer or Weiss ring from PVD can cause the patient to experience moving floaters in front of the eyes, such as filaments, dots, blocks, and other patterns, especially in the bright backgrouds[4]. In recent years, vision degrading myodesopsia (VDM) has become a common term for this disease[5].

The majority of VDM patients may neuroadapt to their disease or grow accustomed to it, and floater symptoms may also lessen as the vitreous floaters shift anteriorly and away from the visual axis[6]. In our previous study, about 40% of patients experienced spontaneous remission of floater symptoms during long-term follow-up[7]. A tiny number of patients, however, believe that floaters significantly affect their quality of life and seek treatment as a result[8-9]. The two main therapeutic options are pars plana vitrectomy and yttrium-aluminum garnet (YAG) laser vitreolysis, each of which has benefits and drawbacks. Although vitrectomy has been shown to reduce the symptoms of floaters and is regarded as a successful treatment, it may have greater adverse effects than laser therapy[10-11]. YAG laser therapy has been demonstrated to be both effective and secure[12]. In our previous prospective study, 72.55% of patients reported significant improvement in floater symptoms[13]. As with the other studies, the follow-up period was brief[14-17].

Since it is well known that vitreous liquefaction is a gradual and ongoing process, it remains to be seen if the effects of YAG laser therapy can be maintained and if laser damage to collagen fibers will cause more tension and problems with the retina. Therefore, the purpose of this investigation was to examine the long-term efficacy and safety of YAG laser vitreolysis for VDM.

SUBJECTS AND METHODS

Ethical Approval This study adheres to the Declaration of Helsinki's principles and was given institutional review board approval. All patients were made aware of their rights and signed the consent forms.

Study Design and Participants This study had a retrospective design. The VDM patients who underwent YAG laser vitreolysis between January 2019 and December 2020 at He Eye Specialist Hospital were collected. Inclusion criteria were: 1) all the vitreous floaters were PVD type; 2) the symptoms of floaters should last at least 3mo[13]; 3) floaters should be ≥3 mm from the inner surface of the retina and ≥5 mm from the posterior surface of the lens[13-14], the B-scan ultrasound images and lens thickness on a slit lamp examination could help to measure that distance[13]; 4) only one eye had YAG laser vitreolysis; 5) the minimum follow-up time was 12mo. Exclusion criteria were: 1) patients with evidence of retinal tears, vitreous retinal traction or lattice degeneration, retinal detachment, uveitis, or severe cataract at baseline; 2) patients who had cataract surgery during follow-up; 3) patients who had intravitreal injection or vitrectomy surgery during follow-up.

Ophthalmological Examination Patients underwent anterior segment examination with a slit lamp, best corrected visual acuity, intraocular pressure (IOP), vitreous and fundus examination via dilated pupil, and an ocular ultrasound B scan (MD-2400S, MEDA Co., Ltd, Tianjin, China). Several eyes underwent Optos (Optos® 200Tx, Optos®, Dunfermline, UK) imaging examinations (Figure 1). In the ocular ultrasound B scan, the vitreous status was determined through the eyelid contact method with gel. A 10 MHz probe was used to examine the mobility of the posterior vitreous during saccadic eye movements using both vertical and horizontal views. All baseline ultrasound B-scans were performed by the same physician. A visible Weiss ring or a detached posterior hyaloid on vitreous and fundus examinations and/or B-scan ultrasonography imaging were used to identify PVD[18].

YAG Laser Treatment Procedure A retinal expert (Lin TZ) performed all the YAG laser vitreolysis procedures. A Q-switched neodymium:YAG laser (Ultra Q Reflex laser, Ellex Medical Lasers Ltd., Adelaide, Australia) was used in this study[19]. A Volk Singh Midvitreous lens was contacted on the cornea with gel (Dikeluo® Ofloxacin Eye Ointment, Shenyang Sinqi Pharmaceutical Co., Ltd., China) after topical anesthesia (oxybuprocaine hydrochloride eye drops, Santen Pharmaceutical Co., Ltd., Japan). Floaters were initially observed at a magnification of 10× and then targeted at a magnification of 16×. The initial laser power was 5 mJ, which was progressively raised until gas bubbles were seen. The complications due to the treatment procedure were recorded[13,20].

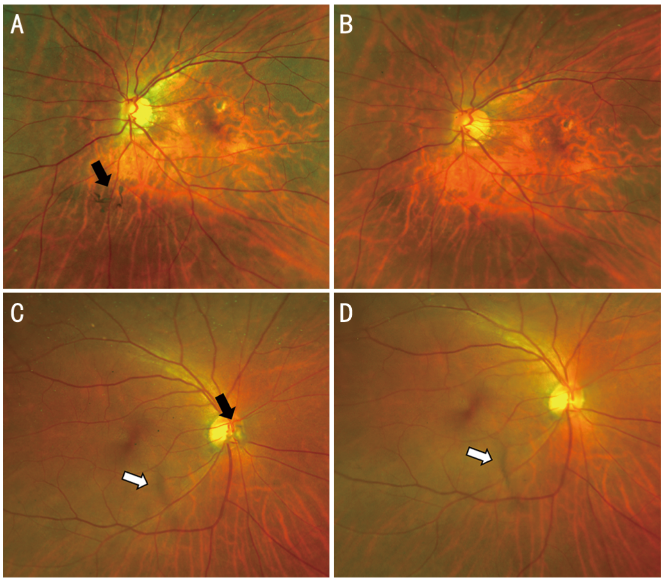

Figure 1 Optos images before and after YAG laser vitreolysis A: A Weiss ring (black arrow) inferior to the optic nerve noted in the left eye of a 54-year-old female with myopia; B: The Weiss ring disappeared after laser therapy, the patient felt complete resolution of floater symptoms; C: A Weiss ring (black arrow) in front of the optic nerve with a piece of cloudy opacity (white arrow) inferior to the macula in the right eye of a 64-year-old male; D: The Weiss ring resolved after laser therapy, but the cloudy opacity (white arrow) remained, and the patient felt partial resolution of floater symptoms.

Data Collection and Outcome Assessment From the medical records of each patient, baseline demographic information, including gender, age, and involved eye, was extracted. As in our previous study, patients were shown an illustration of vitreous floaters with five distinct patterns[7]. Individually, each patient selected only one pattern that resembled their floaters at baseline. Patients were asked to report the number of floaters at baseline, which were then classified as ≤3 or >3. A subjective improvement (ranging from 0 to 100%) and a 5-level qualitative scale at the final visit were the primary outcome measures[21]. A resolution of floater symptoms of ≥50% was considered a significant improvement.

Statistical Analysis The mean and standard deviation (SD) served as representations of continuous values, whereas percentages served as representations of categorical variables. Multivariate and univariate binary logistic regression analyses were used to figure out the risk factors associated with the significant improvement of floater symptoms following YAG laser vitreolysis. The statistical power was established at 95%, while the alpha level was established at 0.05. All statistical analyses were performed using SPSS (SPSS Inc., USA), version 27.0.

RESULTS

Patient Characteristics Based on the study's inclusion and exclusion criteria, a total of 221 patients were enrolled (Figure 2). With a clear female majority (70.59%), the mean age of all patients was 61.08±7.74y, and the mean follow-up time was 21.38±5.61mo (Table 1). Totally 57.01% of patients reported significant improvement or complete resolution of their floater symptoms; 9.95% of patients reported partial improvement; and no patients reported worsening of their floater symptoms at the final visit (Figure 3). Totally 183 patients (82.81%) received one session of YAG laser treatment; the remaining patients received two or more sessions.

Significant Improvement Associated Factors Age [odds ratio (OR)=1.055, 95% confidence interval (CI)=1.017-1.095, P=0.004] and cloudy pattern (OR=0.492, 95%CI=0.229-1.060, P=0.070) were significantly correlated with significant improvement of YAG laser therapy in the univariate analysis. Age (OR=1.049, 95%CI=1.007-1.092, P=0.021) was significantly associated with the success of YAG laser therapy in the multivariate analysis. The lamelliform pattern (OR=0.412, 95%CI=0.166-1.023, P=0.056) and cloudy pattern (OR=0.474, 95%CI=0.211-1.068, P=0.072) tended to have a suboptimal therapeutic effect (Table 2). Significant improvement was seen in 62.86% of patients with spotty floaters, 62.50% of patients with string-like floaters, 41.94% of patients with lamelliform floaters, 66.6% of patients with blocky floaters, and 41.67% of patients with cloudy floaters following YAG laser vitreolysis (Figure 4).

High Myopia and Complications There were 6 patients with high myopia (≥6.0 D) in the current study, and 5 patients (83%) reported the number of floaters was >3 in their eyes. Only one patient (16.67%) felt significant improvement after YAG laser vitreolysis; one patient just felt partial improvement even after 4 sessions of YAG laser vitreolysis. There were 4 patients (1.81%) complained of the floater symptoms being recurrent (2-24mo) in all patients, but only one received repeat YAG laser therapy, others did not find the floaters bothersome. None of the patients reported any side effects or complications due to YAG laser vitreolysis. Focal cataracts, elevated IOP, retinal hemorrhage, or retinal detachment were not found in any patients during their follow-up visit to the hospital.

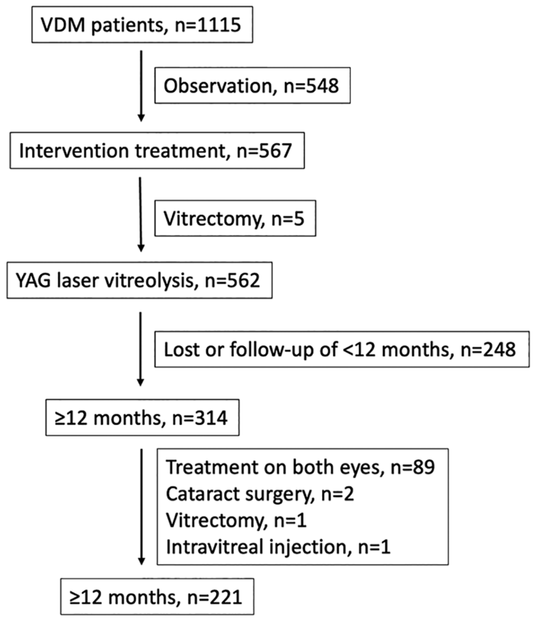

Figure 2 Diagram illustrating the inclusion and exclusion of study participants.

Table 1 Patients' demographic information *n* (%)

Items	*n*=221
Gender	
Male	65 (29.41)
Female	156 (70.59)
Age (y, mean±SD)	61.08±7.74
Myopia	41 (18.55)
Patterns of floaters	
Spotty	70 (31.67)
String-like	40 (18.10)
Lamelliform	31 (14.03)
Blocky	36 (16.29)
Cloudy	44 (19.91)
Number of floaters (*n*)	
≤3	134 (60.63)
>3	87 (39.37)
Follow-up time (mo)	21.38±5.61
Significant improvement	126 (57.01)

SD: Standard deviation.

DISCUSSION

As per some previous studies[13-16], PVD was found to be more prevalent in female patients in the present study. According to Chuo *et al*[22], the PVD change in female patients was double that in male patients. Regardless of age or myopia, there was a definite and persistent association between PVD and menopause. The hormone fluctuations that occur during perimenopause may influence the synthesis and metabolism of glycosaminoglycans. This alters either the vitreous collagens or the vitreoretinal interface[18,23].

In numerous prospective trials, the subjective effectiveness of YAG laser therapy for vitreous floaters during the short-term

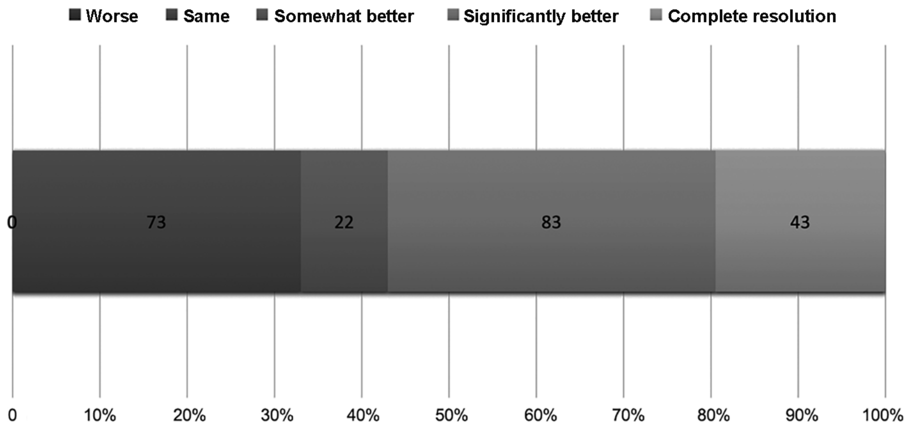

Figure 3 Subjective performance on a five-point qualitative scale (*n*=221) Worse: less than 0; Same: 0 to 30%; Somewhat better: 30% to 50%; Significantly better: ≥50%; Complete success: 100%. No patients complained worsening of their floater symptoms at the final visit.

Table 2 Univariate and multivariate logistic regression analyses for variables associated with significant symptom improvement

Variate	Univariate analysis		Multivariate analysis	
	OR (95%CI)	*P*	OR (95%CI)	*P*
Age (y)	1.055 (1.017-1.095)	0.004	1.049 (1.007-1.092)	0.021
Female	1.200 (0.670-2.148)	0.539	-	-
Myopia	0.522 (0.263-1.035)	0.063	0.854 (0.390-1.872)	0.693
Number of floaters				
≤3	-			
>3	0.757 (0.439-1.305)	0.317	0.661 (0.357-1.222)	0.187
Patterns of floaters				
Spotty	-			
String-like	0.985 (0.441-2.198)	0.970	0.849 (0.368-1.959)	0.701
Lamelliform	0.427 (0.180-1.011)	0.053	0.412 (0.166-1.023)	0.056
Blocky	1.182 (0.507-2.753)	0.699	1.086 (0.443-2.663)	0.857
Cloudy	0.492 (0.229-1.060)	0.070	0.474 (0.211-1.068)	0.072

OR: Odds ratio; CI: Confidence interval.

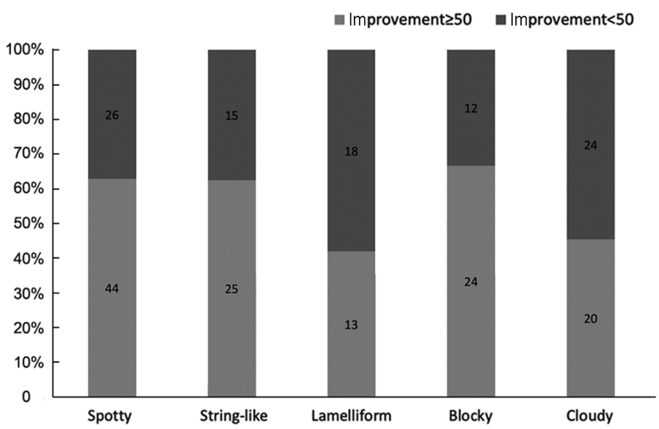

Figure 4 Significant improvement of floater symptoms in different patterns of floaters (*n*=221).

follow-up was between 53% and 77%[13-15]. In an observational extension trial with 35 patients and a mean 2.4-year follow-up period, the efficacy of YAG vitreolysis was maintained at 50%[24]. This outcome was consistent with the current study, which had a much larger sample.

In this study, one-third of patients had no significant response to YAG laser treatment. Although the patterns of floaters were not risk factors for treatment outcomes, fewer patients with cloudy and lamelliform floaters got significant improvement compared to the other three patterns. Janeková *et al*[25] also discovered that laser vitreolysis is more appropriate for isolated than diffuse vitreous opacities. There were four patients who complained of the floater symptoms being recurrent due to the formation of new floaters. Consequently, we hypothesized that the remaining visible posterior vitreous membrane or the presence of collagen-aggregating floaters in addition to Weiss rings may have contributed to the unsatisfactory results.

In addition, the floaters are usually numerous and dense in highly myopic eyes. In this study, 83% of patients with high myopia reported having more than three floaters. Sometimes the floaters in high myopia are hard to aim due to the long ocular axis[20]. It is challenging for YAG laser vitreolysis. A few studies have talked about this situation[13]. In the current study, only one patient was satisfied with the YAG laser therapy, and another felt only partial improvement even after getting four laser treatment sessions. That means YAG laser vitreolysis is not a good option for this kind of floater. Additionally, floater symptoms in myopic eyes were hard to get into spontaneous remission in a previous study[7]. Therefore, vitrectomy may be better for this kind of floater because of its high success rate[26].

In the present investigation, older age was identified as a factor that contributed to the success of YAG laser vitreolysis. Because contrast sensitivity (CS) declines with age after 40[27-29], the likelihood of incident CS impairment declines by 39% per generation[30]. We hypothesized that the elderly's diminished CS could make them more tolerant of floaters. In addition, individuals with cataracts rarely complained of floater symptoms, but some patients did so following cataract surgery[31]. Unfortunately, CS measures were absent from the current investigation.

According to a study using pooled data, isolated floaters were linked to a significant risk of developing retinal tears (16.5%), but at follow-up (4–8wk), the risk fell to 3.9%[32]. According to van Overdam[33], the development of retinal tears happens more rapidly after the onset of floater symptoms. In the current study, patients with evidence of retinal tears, vitreous retinal traction, or lattice degeneration were excluded. The patients undergoing YAG laser vitreolysis had symptoms of floaters for at least 3mo, so retinal tears or retinal detachment were not detected during the long-term follow-up. However, Shah and Heier[24] reported that three out of 35 patients with floaters who underwent YAG laser therapy did not have retinal breaks at the 6-month visit but had retinal tears at the 2.3-year follow-up for an unknown reason. Therefore, patients with VDM should be required to have a thorough initial retinal examination and a follow-up assessment.

Although some case reports also reported some rare complications of YAG laser vitreolysis, such as focal cataracts, refractory open-angle glaucoma, and retinal hemorrhage[34]. The current study didn't find any of the aforementioned complications. Carefully assessing the position of floaters relative to the lens and retina during the treatment procedure is crucial[20].

There are currently no randomized controlled trials comparing YAG laser vitreolysis to vitrectomy as a treatment for VDM[35]. However, according to previous research, vitrectomy appears to have a higher rate of success. More recently, a number of articles have reported patient satisfaction rates ranging from 85% to 97% following micro-incision vitrectomy for floater removal[36]. However, vitrectomy is also associated with more complications, including cataract formation (55%), increased IOP/glaucoma (2.4%), cystoid macular edema (2.2%), epiretinal membrane formation (2.1%), vitreous hemorrhage (0.8%), and endophthalmitis (0.1%)[37]. In the Intelligent Research in Sight Registry, 17 615 eyes that underwent vitrectomy for vitreous opacities had a 12.4% cataract surgery return rate and a 3.7% non-cataract surgery return rate within a year[38].

This investigation had numerous limitations, including a single-center design, a retrospective methodology, and no randomization. PVD was not evaluated with optical coherence tomography. Additionally, the change in visual quality was not evaluated using the visual function questionnaire. However, to the best of our knowledge, this is the largest sample of research on YAG laser vitreolysis with a lengthy follow-up period as well as the first study to examine the risk variables connected to the effectiveness of YAG laser vitreolysis.

In summary, YAG laser vitreolysis for VDM of the PVD type was effective and safe. Older patients are more likely to get satisfactory results. Most patients only need one YAG laser treatment session.

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