Laser Vitreolysis for Vitreous Floaters: An Evidence Review

Introduction

Vitreous floaters are among the most common complaints in ophthalmic practice. They result from age-related vitreous degeneration in which dissociation of hyaluronan from collagen causes fibrous aggregation, liquefaction, and ultimately posterior vitreous detachment (PVD). The resulting opacities scatter light and cast shadows on the retina, perceived as floaters. Prevalence increases with age and myopia; the global increase in myopia prevalence is likely driving an increasing burden of disease.

The traditional approach has been reassurance. This position is increasingly challenged by evidence that floaters can significantly impair contrast sensitivity, reading speed, and quality of life. Sebag and colleagues have shown that contrast sensitivity function (CSF) is substantially degraded in patients with vitreous floaters compared with age-matched controls, with reported reductions of roughly 50% to 90%

across studies depending on the cohort and testing method (1,24); quality of life scores are comparable to those seen in moderate macular degeneration (2). The health utility value associated with visually significant floaters has been reported as low as 0.67, comparable to age-related macular degeneration and diabetic retinopathy (3).

Two interventional options exist: pars plana vitrectomy (PPV) and Nd:YAG laser vitreolysis. This review examines the current evidence for laser vitreolysis.

Mechanism

Laser vitreolysis uses Q-switched Nd:YAG laser (1064nm) to deliver nanosecond pulses that produce optical breakdown and plasma formation at the focal point. The resulting photomechanical disruption vaporises collagen and hyaluronan into gas bubbles that are absorbed over days. The mechanism is identical to that used in posterior capsulotomy; the difference lies in the target location (mid-vitreous rather than anterior segment) and the energy levels typically employed.

Standard capsulotomy YAG lasers use energies of 1-2 mJ. Dedicated vitreolysis platforms such as the Ellex Ultra Q Reflex (now Ellex/Novartis) use higher energies up to 10 mJ per pulse. These systems also employ coaxial illumination rather than the non-coaxial slit-lamp illumination of conventional YAG lasers. Coaxial illumination is considered important for visualising floaters in the mid and posterior vitreous; conventional YAG systems were designed for anterior segment work and have limited utility for deeper targets (4,5).

The distinction between the laser platform used is clinically important. Much early published scepticism about vitreolysis was based on experience with standard capsulotomy lasers at low energy settings. Proponents argue that the newer dedicated platforms, with higher energy capability and improved illumination, represent a different procedure (5).

Evidence for Efficacy

Randomised Controlled Trials

The evidence base is small. Only three sham-controlled RCTs have been published. A 2017 Cochrane review found no RCTs directly comparing YAG vitreolysis to PPV (6).

Shah and Heier (2017) conducted the first sham-controlled RCT. This single-centre trial enrolled 52 patients with symptomatic Weiss ring floaters of at least 6 months duration. Patients were randomised 2:1 to YAG vitreolysis (n=36) or sham (n=16). The Ellex Ultra Q Reflex laser was used with a maximum energy of 7 mJ per pulse. The mean number of shots was 218 (range 33-763). At 6 months, 53% of the YAG group reported symptoms as significantly or completely improved versus 0% in the sham group ($p<0.001$). The visual disturbance score improved from 6.4 to 3.3 in the YAG group; sham was unchanged. Objective masked grading of colour photography showed 94% of treated eyes had significantly improved or resolved floaters versus 0% of sham eyes. NEI VFQ-25 scores improved in the YAG group for general vision, peripheral vision,

role difficulties, and dependency. BCVA was unchanged in both groups. No serious adverse events occurred. One pseudophakic IOL was pitted peripherally (7).

Several methodological criticisms apply. The study was small. Randomisation was 2:1 rather than 1:1. Only Weiss ring floaters were included; this represents the most favourable phenotype for treatment and the results cannot be generalised to other floater types. The sham was imperfect; the low-energy sham (0.3 mJ) is likely distinguishable from therapeutic doses by patients. Duration was limited to 6 months. The study was underpowered to detect uncommon complications. Sebag and colleagues raised these concerns formally, noting a 47% non-response rate even for this favourable floater subtype (8).

A notable discrepancy exists between the 94% objective improvement and 53% subjective improvement. This gap is unexplained. It suggests that either the objective grading overestimates clinical benefit, or that patient expectations exceed what can be delivered, or both.

Ludwig et al. (2021) reported a second sham-controlled

RCT from Brazil. This enrolled 24 patients randomised to YAG vitreolysis or sham. Contrast sensitivity improved significantly in the treatment group. Results broadly supported the Shah and Heier findings but the sample was even smaller (9).

A trial protocol by Zhang et al. (2024) describes a planned RCT of 70 participants evaluating early versus delayed vitreolysis. Results are not yet available (10).

Prospective Uncontrolled Studies

Luo et al. (2022) prospectively treated 51 eyes and reported 71% symptomatic improvement at 6 months. They compared PVD and non-PVD subgroups and found better outcomes in the PVD group. Objective measures including Strehl ratio and modulation transfer function improved post-treatment (11).

Serracarbassa et al. (2020) treated 32 eyes with PVD-related floaters. Colour fundus photography showed improvement in 93.7% of eyes (complete in 56.2%, partial in 37.5%). NEI VFQ-25 near visual function and visual dis-

turbance scores improved significantly. No adverse events were observed at 6 months (12).

Retrospective Studies

Lin et al. (2023) reported the largest retrospective series: 221 patients with PVD-type floaters followed for a mean of 21 months. 57% reported significant improvement. Older age was a predictor of success. No retinal tears, detachments, or other complications were observed during follow-up. High myopia predicted poor response; only 1 of 6 highly myopic patients improved significantly (13).

Delaney et al. (2002) reported one of the earlier case series from the UK. In 39 eyes treated with YAG vitreolysis (maximum 1.2 mJ per burst), symptomatic relief was described as "moderate" in 36%, with 54% experiencing no relief and 7.7% feeling worse. The authors concluded vitreolysis was safe but only moderately effective, benefiting approximately one-third of patients. Of note, this study used a conventional capsulotomy YAG at low energies, not a dedicated vitreolysis platform (14).

Tsai et al. (1993) reported early experience from Taiwan in 15 patients. This study is frequently cited as foundational but used low energies by current standards (15).

Objective Structural Assessment

Nguyen et al. (2019) published the most methodologically rigorous assessment of vitreous structure and visual function after YAG vitreolysis. This retrospective comparative study from the VMR Institute (Sebag's group) compared 38 previously laser-treated patients to 59 untreated floater patients and 35 controls without floaters. Quantitative ultrasonography showed treated eyes had 23% less vitreous echodensity than untreated floater eyes ($p<0.001$), confirming structural effect. However, there were no differences in NEI VFQ-39 scores ($p=0.51$), BCVA ($p=0.42$), or CSF ($p=0.17$) between treated and untreated groups. Of the 38 treated patients, 25 (66%) were dissatisfied and seeking vitrectomy. Those seeking vitrectomy had 24% greater residual vitreous echodensity and 52% worse CSF than those satisfied with observation. The authors concluded that YAG laser reduces vitreous density but does

not meaningfully improve visual function in the majority (16).

This study has important limitations. It was conducted at a tertiary vitreoretinal referral centre, introducing selection bias toward dissatisfied patients. The laser treatments were performed elsewhere in the community without standardised protocols. Nevertheless, the finding that structural improvement does not reliably translate to functional benefit is significant and consistent with the Shah and Heier objective-subjective discrepancy.

Safety

Reported Complications

The ASRS Research and Safety in Therapeutics (ReST) Committee published a voluntary reporting analysis in 2019. Over a 6-month collection period, 16 complications were reported in 15 patients by 7 US retinal specialists. These included:

- Focal cataract: 5 cases (3 within visual axis, 2 with posterior capsule rupture requiring cataract surgery)

- Prolonged IOP elevation: 5 cases (3 progressing to secondary glaucoma, 2 requiring trabeculectomy)
- Retinal detachment: 2 cases
- Retinal tear: 1 case
- Retinal haemorrhage: 2 cases
- Scotoma: 1 case
- Increased floaters: 1 case (17)

This is a voluntary reporting system without denominator data. The true incidence of complications is unknown. However, the spectrum is concerning for a procedure treating a benign condition.

Additional case reports document:

- **Secondary open-angle glaucoma** requiring Baerveldt valve implantation, following a case series by Cowan et al. reporting 3 cases of refractory glaucoma after vitreolysis (18,19).
- **Cystoid macular oedema** confirmed on fluorescein angiography following vitreolysis (20).
- **Bilateral posterior capsule injury** from misdirected laser (21).

- **Rapid cataract progression** requiring surgery (22).

Shah and Heier's long-term follow-up reported that 3 of 35 treated patients developed retinal tears at a mean of 2.3 years post-treatment; whether these were causally related is unknown (13).

Risk Mitigation

Practitioners recommend maintaining a minimum distance of 2 mm from the retina and crystalline lens. Shah required 5 mm posterior to the posterior capsule and 3 mm anterior to the retina, measured by B-scan. Some authors recommend limiting total shots to fewer than 300 per session and avoiding treatment in patients with pre-existing glaucoma, lattice degeneration, or phakic lenses at high risk. Recommendations not to perform vitreolysis at the same sitting as posterior capsulotomy have also been made (5,17).

Singh reported an adverse event rate of 0.8% in a personal series of 1,264 cases (7 IOP spikes, 2 lens injuries, 1 retinal haemorrhage) (23). These figures are reassuring if

accurate, but come from a single high-volume practitioner and are not externally validated.

Comparison with Vitrectomy

PPV remains the definitive treatment for visually significant floaters. Success rates of 90-95% are consistently reported. Sebag's series of 151 eyes reported CSF normalisation within 7 days of surgery, sustained over years. In Delaney's comparative series, full symptomatic resolution occurred in 93.3% of vitrectomy patients versus approximately one-third with vitreolysis (14).

Vitrectomy carries its own risks: cataract (inevitable in phakic patients; 35-87% depending on extent of vitrectomy), retinal tears (reported up to 10.9%), endophthalmitis, and the general risks of intraocular surgery. The use of small-gauge (25G/27G) surgery has mitigated some of these risks. A modified limited vitrectomy approach focusing on central vitreous removal, as advocated by Sebag, may reduce cataract rates (35% at 24 months versus 87% with extensive vitrectomy) (24).

The Cochrane review (2017) found no RCTs comparing vitreolysis to vitrectomy directly and concluded that appropriately designed RCTs are needed (6).

Regulatory and Guideline Position

NICE (UK)

NICE published interventional procedures guidance (IPG741) on YAG laser vitreolysis for symptomatic vitreous floaters. The recommendation states:

> "Evidence on the safety and efficacy of YAG laser vitreolysis for symptomatic vitreous floaters is inadequate in quality and quantity. Therefore, this procedure should only be used in the context of research."

NICE further stipulated that the procedure should only be performed by retinal specialists experienced in laser surgery with expertise in managing vitreoretinal disease. Research should include adequately powered RCTs reporting details of patient selection, degree of visual disturbance, and procedural parameters (25).

FDA (US)

The US FDA classified YAG laser vitreolysis as a "non-significant risk" procedure when approving YAG lasers for this indication. This classification permitted marketing of dedicated vitreolysis platforms. The FDA position does not imply proven efficacy (17).

Patient Selection

The available evidence suggests that, if the procedure is to be considered, optimal candidates share certain characteristics:

- **Weiss ring or solitary dense opacity** rather than diffuse cloud-like or multiple tiny floaters
- **Complete PVD** with the opacity located in the mid-vitreous (adequate distance from both lens and retina)
- **Pseudophakic status** (eliminates cataract risk and improves visualisation)
- **No pre-existing glaucoma or retinal pathology**
- **Symptoms of at least 6 months duration** with

documented stability

Poor candidates include those with diffuse vitreous opacification, myopic vitreopathy without discrete opacities, high myopia, phakic lenses with narrow vitreous cavities, 360-degree lattice degeneration, glaucoma, and those with unrealistic expectations (5,7).

Critical Appraisal

The evidence base for laser vitreolysis is weak. The strongest available study (Shah and Heier) enrolled only 52 patients, examined only the most favourable floater phenotype, followed for only 6 months, and demonstrated a 47% non-response rate even in this selected group. The objective-subjective discrepancy is unexplained. The Nguyen/Sebag study suggests that structural improvement does not reliably produce functional benefit.

Against vitrectomy, which has well-established efficacy approaching 95%, vitreolysis offers modest benefit in a subset of patients. The argument for vitreolysis rests on its non-invasive nature; the counterargument is that for

a benign condition, the risk-benefit ratio must be very favourable, and the current complication profile raises concerns.

There is a conflict of interest dimension. The Ellex Ultra Q Reflex laser was specifically marketed for vitreolysis. Much of the supportive literature comes from practitioners with close relationships to the manufacturer. The opposing literature comes substantially from Sebag's group, which advocates vitrectomy. Neither position is disinterested.

The NICE position appears well-calibrated: the evidence is inadequate and the procedure should be confined to research settings until properly powered RCTs are available.

Conclusions

Laser vitreolysis using dedicated YAG platforms can reduce vitreous opacity density and produces subjective improvement in approximately 50-60% of carefully selected patients with Weiss ring floaters. For other floater phenotypes, evidence of efficacy is absent or poor. Serious complications are uncommon but include cataract, glau-

coma, retinal detachment, and retinal damage. Long-term safety data are sparse. The procedure does not reliably improve contrast sensitivity or visual function measures despite reducing structural vitreous density.

Current evidence does not support widespread adoption. NICE restricts its use to research settings. Any clinician offering this procedure should do so within a framework of prospective data collection, rigorous informed consent covering the uncertain evidence base, and careful patient selection. The need for adequately powered, multicentre, sham-controlled RCTs with standardised floater classification and validated outcome measures remains urgent.

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