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Efficacy and safety of yttrium-aluminium garnet (YAG) laser vitreolysis for vitreous floaters

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Abstract

Objective: To examine the efficacy and safety of yttrium-aluminium garnet (YAG) laser vitreolysis for the treatment of vitreous floaters.

Methods: Consecutive adult patients with symptomatic vitreous floaters who attended Chongqing General Hospital from April to December 2016 were included in this prospective study. Patients had $>$3 mm between the vitreous opacity and retina/lens and acceptable quality peri-papillary Optical Coherence Tomography (OCT) images (i.e., signal strength $\geq$5). Those with history of glaucoma, severe cataracts, vitreous haemorrhages, retinal holes and/or macular disease were excluded from the study. Best corrected visual acuity (BCVA) and non-contact intraocular pressure (IOP) were measured before and for up to 6 months post-YAG laser vitreolysis. Anterior segment photography and peripapillary retinal nerve fibre layer (RNFL) measured by OCT were taken before and 6 months post-procedure. Questionnaires on patient satisfaction were completed 6 months post-procedure.

Results: No statistically significant differences in BCVA and IOP were observed before or after treatment. Anterior segment photography showed that vitreous opacities partially or completely disappeared after YAG laser treatment. The thickness of RNFL in four directions (upper, below, nasal and temporal) was not statistically significant different before or 6 months after the procedure. 75% patients reported significant improvement and 25% reported moderate improvement.

Conclusion: The results of this study conducted in a cohort of 30 Chinese patients showed that YAG laser vitreolysis was a well-tolerated and effective treatment for vitreous floaters. Randomised, controlled trials involving large numbers of participants monitored over an extended follow up period are required to confirm these results.

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Keywords

Yttrium-aluminium Garnet laser vitreolysis, vitreous floaters, anterior segment photography, optical coherence tomography, peripapillary retinal nerve fibre layer

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Introduction

Vitreous floaters are most commonly caused by posterior vitreous detachment (PVD), vitreous syneresis and asteroid hyalosis and can cause black shadows, decreased vision and intraocular glare.[1] Although these symptoms are considered as non-pathological, they can be of considerable inconvenience for many patients. For example, myopic patients who have had PVD from an early age are particularly sensitive because the symptoms may become severe due to retinal image magnification.[2] Nevertheless, few patients with symptomatic floaters are offered an intervention. For those patients with symptomatic vitreous opacities, yttrium-aluminium garnet (YAG) laser vitreolysis has been proposed as a treatment option.[3] The YAG laser is non-invasive and via a special optical lens has been reported to provide accurate localization of floaters within the vitreous cavity.[4] The objective of this study was to examine the efficacy and safety of YAG laser vitreolysis in the treatment of vitreous floaters in a cohort of Chinese patients.

Patients and methods

This prospective study was conducted at the Chongqing General Hospital (Chongqing, China) from April to December 2016 and involved patients with vitreous floaters. All patients were symptomatic and had a strong desire for remedial treatment. The distance between their vitreous opacity and retina or lens was >3 mm as measured by B-scan ultrasound. In addition, only subjects with acceptable quality of peripapillary Optical Coherence Tomography (OCT) images (i.e., signal strength $\geq$5) were included in the study. Patients with a history of glaucoma, severe cataracts, vitreous haemorrhages, retinal holes and/or macular disease were excluded from the study.

Anterior segment photography using a Volk Digital High Mag optic lens and measurements of the thickness of peripapillary retinal nerve fibre layer (RNFL) assessed by OCT (NIDEK RS-3000 LIST) were taken before and 6 months after the procedure. Each OCT volume was $200 \times 200 \times 1024$ voxels which corresponded to physical dimensions of $6 \times 6 \times 2$ mm. The best corrected visual acuity (BCVA) and non-contact intraocular pressure (IOP) were measured pre-procedure and thereafter at 1, 3 and 6 months; IOP was also measured 30 min post-procedure.

Prior to the procedure, the patients' eyes were dilated with tropicamide 1% and anaesthetized on the surface with benoxinate 0.4%. In all cases, intravitreal laser treatment was performed by the same surgeon [Y.K.] using YAG laser (NIDEK YC-1800) and optical convex-surfaced contact lens (Karickhoff 21mm Vitreous Lens OJKY-21 or Karickhoff 25mm Off-Axis Vitreous Lens OJKPY-25). A 21 mm lens was used for opacity in the centre of the optic axis and a 25 mm lens was used for opacity off the optic axis. The energy delivered from the laser ranged from 1.5–2.0 mJ at the beginning of the procedure and this level was gradually increased to a value that fully vaporized the opacity. End of treatment was defined as the time when the main dense part of opacity had been vaporized. This timing was no longer than 20 min. In cases of multiple opacities which could not be treated on one occasion, the patient returned for a subsequent procedure a week later. After treatment, the patients received pranoprofen eye drops, four times a day for 5 days.

All patients were asked to complete a questionnaire 6 months post-procedure and were asked to rank their improvement as one of the following: (a) failure: floaters are the same or worse; (b) partial success: some improvement but still floaters of moderate inconvenience; (c) significant success: significant improvement with only slight inconvenience or complete resolution.

This study was reviewed and approved by the ethics committee of Chongqing General Hospital and all patients signed informed consent forms before treatment commenced.

Statistical analyses

Statistical analyses were performed by one investigator [X.A.] using SPSS software (version 19.0 for Windows®; (IBM SPSS, Armonk, NY: IBM Corp, USA). A *P*-value <0.05 was considered to indicate statistical significance. Paired t tests were used to compare RNFL, BCVA and IOP before and after treatment.

Results

A total of 30 eyes from 30 patients (13 men, 17 women) underwent YAG laser vitreolysis. All patients were followed up for an average of 6 months. No post-procedural complications were observed. Patients' mean (±SD) age was 55±0.3 years (range: 38-69 years). All patients had Weiss ring or sheet opacity in the vitreous cavity. Of the 30 cases, 20 were myopic (−1.25D–−4.50D, astigmatism ≤−2.00D), 10 were non-myopic, nine had lens opacity (++) and 21 had no lens opacity. Twenty-four patients had vitreous opacity in the centre of the optic axis and six patients had opacity off the optic axis.

Baseline mean (±SD) IOP before treatment was 15.69±2.99 mmHg and at 30 minutes after the procedure the mean IOP was 16.07±3.03 mmHg. The energy levels of the YAG laser ranged from 1.5–7.0 mJ and its average working time was 17.50 ±0.28 min (range: 13-20 min). The mean (±SD) times of effective laser firing was 58.10±0.77 (range:35-80 times). A single treatment session was required in 25 patients and two sessions were required in the remining five patients.

Patients' BCVA and IOP before/after the treatment are summarized in Table 1. There were no statistically significant differences in BCVA or IOP before or up to 6 months after treatment.

For most patients, the vitreous opacities partially or completely disappeared after YAG laser treatment. The subjective symptoms of vitreous floaters were alleviated as the dense parts of vitreous opacities were vaporized even if there were some cloud-like residues present. Figure 1 shows an example of anterior segment photography of one eye before and six months after the YAG laser treatment. Before treatment, an irregular ribbon-like opacity in the optic axis of vitreous cavity was observed and following YAG laser treatment the ribbon had disappeared and some cloudy segments remained.

The results of the questionnaires on patient satisfaction showed that following YAG laser vitreolysis, 75% of patients recorded ‘significant success’, 25% recorded ‘partial success’ and 0% recorded ‘failure’.

The thickness of RNFL before and 6 months post-procedure are shown in

Table 1. Best corrected visual acuity (BCVA) and non-contact intraocular pressure (IOP) measured before an after YAG laser treatment (n=30).

BCVA (log MAR scale)				IOP (mmHg)				
Baseline	1 month post-laser	3 months post-laser	6months post-laser	Baseline	30 mins post-laser	1 month post-laser	3 months post-laser	6 months post-laser
0.79±0.18	0.79±0.17	0.78±0.19	0.78±0.17	15.69±2.99	16.07±3.03	15.75±2.96	16.06±3.06	15.96±3.25

Values are shown as mean ± standard deviation.
Paired t tests were used to compare BCVA and IOP before and after treatment and none of the comparisons were statistically significant.

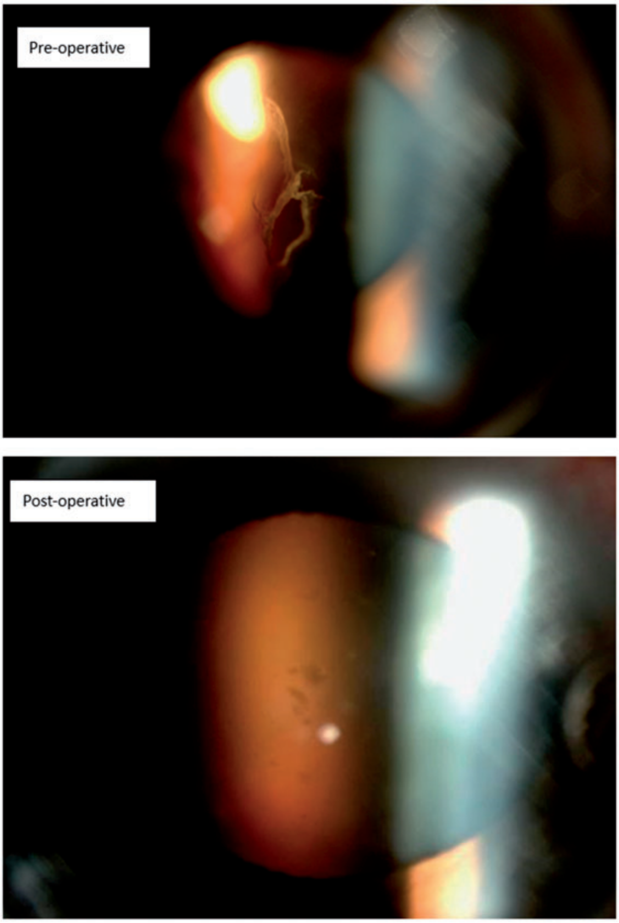

Figure 1. Anterior segment photography with the aid of a Volk Digital High Mag optic lens before and 6 months after YAG laser treatment.
Pre-operative: An irregular ribbon-like opacity in optic axis of vitreous cavity was observed before treatment.
Post-operative: Six months after YAG laser treatment the ribbon had disappeared and some cloudy segments remained.

Table 2. Thickness of peripapillary retinal nerve fibre layer (RNFL) before and 6 months post-procedure.

	Thickness of peri-papillary RNFL (μm)		
Direction	Before procedure	6 months post-procedure	Statistical significance
Upper	129.74±1.56	129.67±1.36	*ns*
Below	131.96±4.43	131.67±4.31	*ns*
Nasal	82.28±3.26	82.60±2.87	*ns*
Temporal	75.67±1.41	75.72±1.39	*ns*

Values are shown as mean ± standard deviation.
ns, not statistically significant.

Table 2. The OCT images provided data on the thickness of the nerve fibre layer in four directions (i.e., upper, below, nasal and temporal). There were no statistically significant differences between pre- and post-procedure values.

Discussion

Normal vitreous body is a transparent gel formed of 98% water and 2% collagen and hyaluronic acid. The collagen fibres are arranged in a three-dimensional grid-like structure to which hyaluronic acid and polysaccharide are attached.[5] The vitreous is characterized by viscoelasticity, permeability and transparency and is a key part of the ocular media acting as a barrier between the anterior and posterior segments of the eye. Vitreous floaters are most commonly caused by PVD, vitreous syneresis and asteroid hyalosis.[1] In these conditions, the collagen framework gradually collapses, the vitreous is transformed into liquid and the cortical vitreous is separated from the internal limiting membrane of the sensory retina.[6–8]

The prevalence of vitreous floaters is increased in the elderly and in patients with an increased axial length. Indeed, floaters have been reported to be common in myopes and after cataract surgery.[9,10] Most patients can tolerate their symptoms, but there is a significant minority who find floaters troublesome because of disturbances in contrast sensitivity and visual quality. Floaters can especially be a problem for myopes, pseudophakes and patients whose employment requires fine detailed work.[10]

For most patients, floaters are treated conservatively with patient education and reassurance. However, more severe cases may require YAG laser vitreolysis or pars plana vitrectomy (PPV). The results of this study conducted in a cohort of 30 Chinese patients showed that YAG laser vitreolysis was a well-tolerated and effective treatment for vitreous floaters. The YAG laser causes evaporation of the degenerated vitreous. Recommendations suggest that the laser should be confined to the anterior vitreous so as to avoid destruction of the vitreous and that its safe working distance should be >2 mm with a maximum energy of ≤1.2 mJ.[11,12] However, the present study showed that the laser can be used in the posterior vitreous and that energy levels of 1.5–7.0 mJ are well-tolerated with no associated complications reported up to 6 months post-procedure. We suggest that the laser's safe working distance should be >3 mm at all times and that the surgeon should pay attention to the movement of the vitreous opacity to avoid hitting the retina. In addition, the specially designed convex-surfaced contact lenses should be used to reduce the energy threshold for plasma formation which further increases the safety of intravitreal YAG laser. Importantly, we believe that the efficiency of a YAG laser session may be improved if it is performed by an experienced surgeon.

A previous study conducted in the USA, reported two cases of open angle glaucoma one week and 8 months after YAG laser vitreolysis with high IOP (i.e., >40 mmHg).[13] In our current study, 30 patients were followed-up for 6 months after YAG laser treatment and no increase in IOP nor any significant change in the thickness of peripapillary RNFL was observed in this cohort of Chinese patients. Further studies with large sample sizes are required to confirm our results.

The use of pars plana vitrectomy (PPV) in the treatment of vitreous floaters is controversial and the intervention is usually only indicated if the floaters are accompanied by vitreous haemorrhage, retinal holes or retinal detachment.[14,15] One study reported that intraocular glare, which is caused by vitreous opacity[16] was significantly reduced after PPV.[17] In China, because of the high cost of PPV and potential surgical risk, it is difficult to recommend PPV in the treatment of vitreous floaters. The YAG laser is more feasible for most patients because compared with PPV, laser treatment has the advantages of being non-invasive, low cost, short duration, immediate effect and less complicated. Moreover, there are currently no randomized, controlled studies that have compared PPV with YAG laser vitreolysis in the treatment of symptomatic floaters and so there is no strong evidence to recommend either procedure for the treatment of symptomatic floaters.[18] Properly designed studies are needed to evaluate the clinical outcomes following these interventions.[18] Limitations of this present study included a small sample size and lack of a comparative study group.

In conclusion, this prospective study conducted in a small sample of Chinese patients showed that YAG laser vitreolysis was a well-tolerated and effective treatment for symptomatic floaters. Although BCVA had not statistically significantly improved from baseline, subjectively, most patients felt that their visual quality had improved and that the treatment was successful. However, before YAG laser vitreolysis can be recommended as a routine procedure for symptomatic vitreous floaters, several randomised, controlled studies involving large numbers of participants monitored over an extended follow up period are needed.

Declaration of conflicting interests

The authors declare that there are no conflicts of interest.

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