LASER VITREOLYSIS IN PATIENTS WITH SYMPTOMATIC VITREOUS FLOATERS

Janeková A.[1-3], Veith M.[3], Fillová D.[1], Janek M.[1]

[1]Eye Centre Prague, Czech Republic
[2]Faculty of Medicine, Charles University in Hradec Králové, Czech Republic
[3]Department of Ophthalmology, Královské Vinohrady University Hospital and 3rd Faculty of Medicine, Charles University in Prague, Czech Republic

The authors of the study declare that no conflict of interests exists in the compilation, theme and subsequent publication of this professional communication, and that it is not supported by any pharmaceuticals company. The study has not been submitted to or printed in any other journal, with the exception of congress abstracts and standard guidelines.

Received: 5 September 2022
Accepted: 21 October 2022
Available online: 30 December 2022

MUDr. Andrea Janeková, FEBO
Oční centrum Praha
Jankovcova 1569/2c
17000 Praha 7
E-mail: janekovaandrea@gmail.com

SUMMARY

Aims: To examine the effectiveness and safety of Nd:YAG laser vitreolysis in patients with symptomatic vitreous floaters.
Material and Methods: This was a single-centre study of adult patients with symptomatic vitreous floaters who underwent laser vitreolysis. Patients treated between 1/2020 and 10/2021 were included. Intraocular pressure was measured by non-contact tonometry before and one month after treatment. Colour fundus photography, slit lamp examination in mydriasis, best corrected visual acuity, optical coherence tomography, and ultrasound examinations were performed before treatment. The patients completed a questionnaire to subjectively rank the degree of impairment associated with the floaters before and between 1 and 2 months after treatment.
Results: 89 eyes from 84 patients were included in the study, with a slight predominance of women (53%). A Weiss ring was present in 46%, and other types of vitreous opacity were found in 54%. Before treatment, 69% evaluated floaters as very troublesome (i.e., a value of 4 or 5 on a 1–5 scale). After treatment, 42% indicated subjective improvement (9% viewed the treatment as a complete success and 33% as a significant success). In 33% of eyes there was a partial improvement, i.e., some floaters could still be seen, and in 17% there was no improvement; 8% of patients were dissatisfied with the treatment results. There was no statistically significant difference in improvement between the group with Weiss rings and the group with other types of floaters. The procedure itself and the subsequent observation period were without complications, i.e., no cases of intraocular pressure elevation, cataract formation or retinal complications. Intraocular pressure did not significantly change from the pre-procedure value ($p = 0.29$). Average best corrected visual acuity after treatment was 0.97, thus it did not differ significantly from the pre-treatment values ($p = 0.82$).
Conclusion: Nd:YAG laser vitreolysis subjectively improved floater-related symptoms in treated eyes. The lack of an objective measurement of treatment success is a limiting factor. Laser vitreolysis is more suitable for solitary than diffuse vitreous opacities.
Key words: floaters, vitreous detachment, laser therapy, Weiss ring, vitreolysis

Čes. a slov. Oftal., 78, 2022, No. 6, p. 288–296

INTRODUCTION

The incidence of vitreous floaters increases with age, primarily due to progressive degenerative changes inside the vitreous body. The vitreous body forms the greatest volume of the eyeball, and is composed of 98% water, as well as collagen fibres and hyaluronic acid. The strongest adhesion of the vitreous body to the retina is localised in the region of the vitreous base, where the highest concentration of collagen and the lowest concentration of hyaluronic acid of the entire vitreous body are located. Other, weaker vitreoretinal adhesions are located in the region of the optic disc margin, above the retinal capillaries and 500–1500 m in the surrounding area of the fovea. At a younger age, hyaluronate maintains the collagen fibrils separated inside the vitreous cavity, and the vitreous body is therefore optically transparent. With ageing of the eye, and frequently also in the case of myopia, an aggregation of collagen and fibrous structures occurs – referred to as vitreous liquefaction [1]. The patient notices dark or grey structures of various shapes (flies, specks, lines), the perception of which is accentuated against a light background, when these shadows are more pronounced, for example when looking at the sky. This phenomenon is clinically described as vitreous floaters.

The detachment of the posterior vitreous membrane (PVD) from the membrane limitans interna (MLI) takes place first of all at the optic nerve papilla, and then continues in an anterior direction. A certain degree of fibroglial structure is perceptible in the vitreous body, floating freely in front of the optic nerve (ON) papilla, known as a Weiss ring. PVD enables movement of the vitreous body, and upon motion of the head the Weiss ring may cause a shadow falling on the retina, perceived as an opacity. Posterior vitreous detachment occurs in approximately 65% of patients aged over 65 years [2]. A higher incidence is stated in the female sex, which may be associated with the biochemical composition of the vitreous body and hormonal changes in the menopause [3]. Despite the fact that the majority of patients become accustomed to the opacities over the course of time, above all in cases where the opacities shift further forwards or outside of the visual axis [4], some patients continue to perceive them as an impairment also for a longer period of time.

For objective documentation of vitreous floaters we can use ultrasound (B-scan), which enables imaging of the vitreous space and the detached posterior vitreous membrane [5,6]. It also enables the use of colour [7] or infrared (IR) photography of the fundus [1]. Assessment of the shadow of the floater according to IR photography has limitations primarily in the contrast between the floater and the background. The study [1] compares the shadow cast upon the retina by the floater and the score of the VFQ-25 questionnaire with a negative coefficient result of 0.7, in which the size of the shadow calculated by the software could correlate with the degree of impairment caused to the patient by the floater. OCT, above all a widefield scan, is suitable for displaying floaters close to the retina, where we may identify the shadow cast by the floater on the surface of the neuroretina. It appears highly beneficial to use confocal scanning laser ophthalmoscopy (cSLO), which enables live imaging of the opacity, and monitoring of its position and motility [8].

At present three main strategies are known for the management of vitreous floaters in patients with other present pathologies. In previous decades the predominant strategy was educating patients after they had undergone a comprehensive eye examination, including examination in mydriasis in order to exclude retinal pathology, and subsequent follow-up observation. With reference to the therapeutic options, the influence of vitreous opacities on quality of life was underestimated. In recent years the management of vitreous floaters has become increasingly proactive, with an endeavour to remove opacities and improve patients' quality of life. Options for the treatment of vitreous floaters include pars plana vitrectomy and Nd:YAG (Neodymium yttrium aluminium garnet) vitreolysis. Pars plana vitrectomy is a procedure enabling the complete removal of vitreous floaters, with a subsequent high level of patient satisfaction. Since this concerns an invasive procedure [9,10], it may be associated with the incidence of complications which require secondary surgical intervention. The published summary study [11] evaluates a total of 17,615 eyes in which pars plana vitrectomy was performed due to the appearance of vitreous floaters. Cataract surgery was required in 12.5% of eyes, and in a further 3.7 % of eyes another secondary surgical procedure was necessary within a period of 1 year after the primary procedure. This most often concerned the incidence of a cataract or retinal tear. Neodymium-doped yttrium aluminium garnet (Nd:YAG) vitreolysis is a non-invasive procedure, which enables the photo-disruption of fibrous vitreous opacities thanks to a special lens displaying the vitreous space and coaxial illumination. The Nd:YAG laser generatesshort, intense pulses with the production of energy which vaporises the afflicted structures and transforms them into plasma. The aim of this study was to monitor the effectiveness of the procedure, subjective patient satisfaction on the basis of a questionnaire, and the incidence of complications during the procedure and the follow-up observation period.

Material and Methods

In this prospective study we observed 89 eyes of 84 patients with symptomatic vitreous floaters, which the patients stated had been persistently present for at least 3 months, within the period from 1/2020 to 10/2021 (Table 1). The patients underwent a comprehensive eye examination, specifically: measurement on an automatic refractometer, measurement of intraocular pressure by non-contact tonometry, fundus photography, determination of

Table 1. Characteristics of patients

Age	63.2 years
Median (range)	63 (40–80)
Women	47 (53%)
Pseudophakic patients	55 (62%)
Weiss ring type floater	46 (52%)
Follow up period	13 months
Median (range)	12 (29–7)
CDVA before treatment (decimal)	0.94
CDVA after treatment (decimal)	0.97

CDVA– corrected distance visual acuity

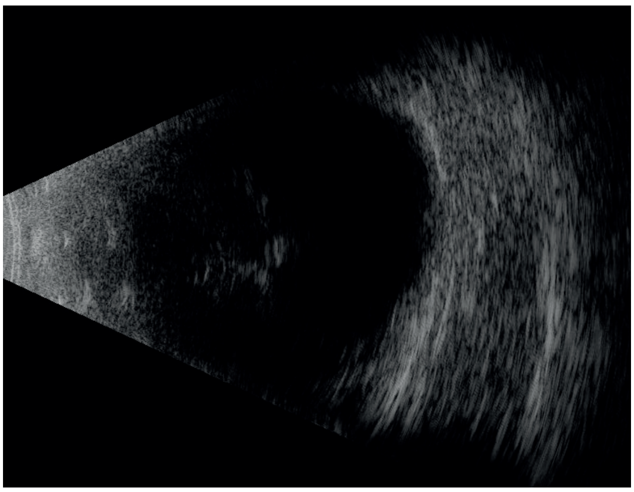


Figure 1. B-scan photograph showing vitreous floater

best corrected distance visual acuity, and examination of a slit lamp in mydriasis in order to exclude peripheral tears or retinal degeneration. Ultrasound examination of the retina was also performed (HiScan touch, Opticon) (Figure 1), as well as a widefield OCT scan (Angiovue, Optovue, Fremont) (Figure 2). Before the procedure itself and at a follow-up examination 1–2 months after the procedure, the urepatients completed a questionnaire which we compiled (Figure 3) concerning their subjective perception of vitreous floaters. The indication for the procedure was the

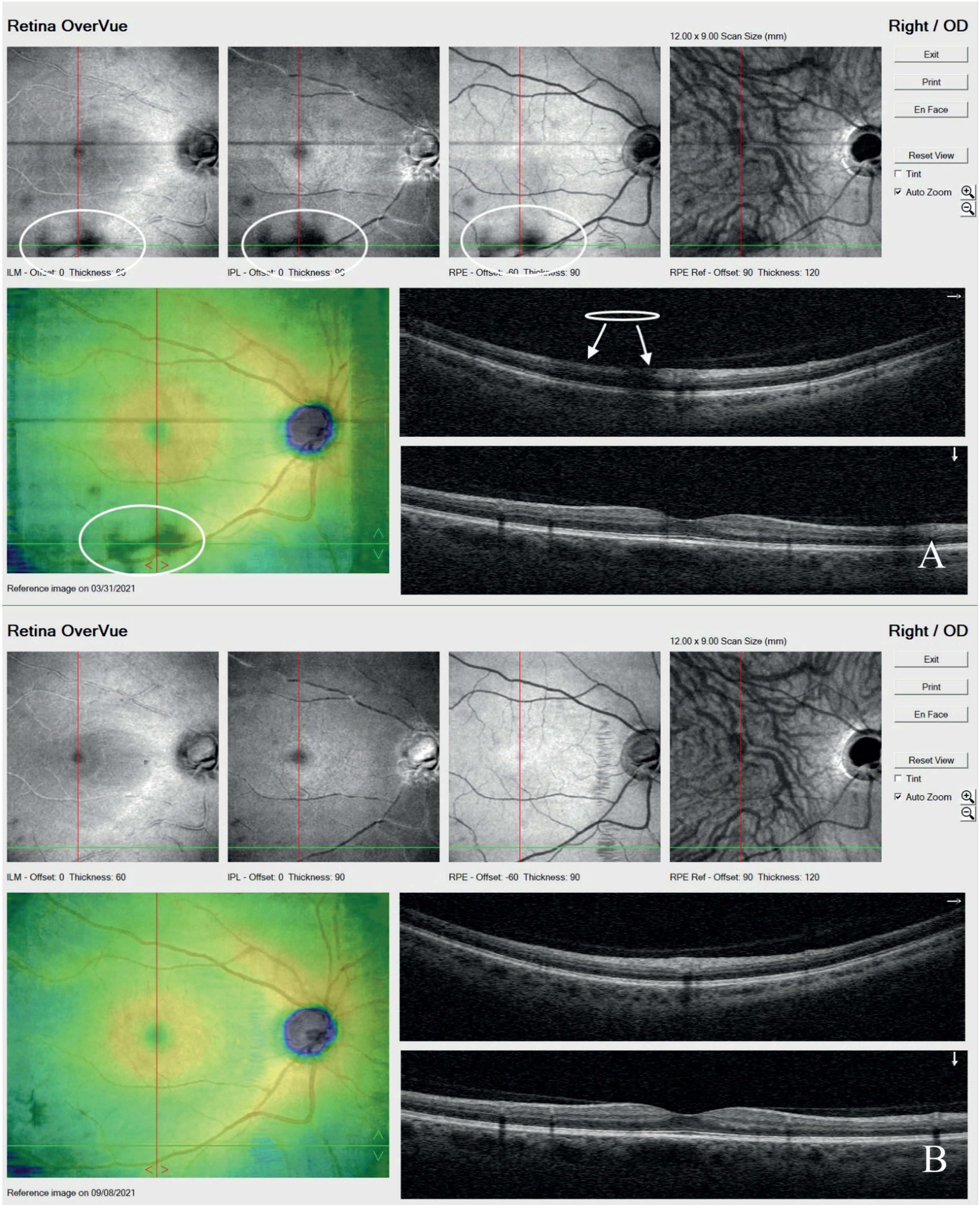


Figure 2. OCT scan showing vitreous floater before **(A)** and after treatment **(B)**. White arrows show shadow of the floater

presence of symptomatic vitreous floaters persisting for a minimum of 3 months, an absence of other peripheral retinal pathologies and a distance of the floater of at least 2 mm from the retina or lens (in the case of a phakic patient). The exclusion criteria covered the presence of vitreous haemorrhage, retinal tear, vitreoretinal proliferation, a history of uveitis or other serious ocular pathology. The patients were divided into the groups of PVD type floater (Weiss ring) and non-PVD floater.

Statistical evaluation

We presented the variables as mean ±SD, values of maximum, minimum and median. A Shapiro-Wilk test was used to test the normality of data. An analysis of values with normal distribution was conducted with the aid of a non-paired T-test, for the other values a Mann-Whithey test was used. In determining significance, a level of p smaller than 0.05 was considered statistically significant. Software used for the evaluation was Excel version 2019 (Microsoft corporation) and the program STATISTICA software (version 12.7; Dell Software Inc.).

Procedure

Before the actual procedure, eye drops were applied in order to induce mydriasis (tropicamide, phenylephrine hydrochloride), as well as local anaesthetic (oxybuprocaine hydrochloride). The procedure was performed on an Nd:YAG laser instrument (Ultra Q Reflex-YAG, Ellex Me-

Laser vitreolysis-questionnaire before treatment

Name and surname ………………………………………………………… **Age** …………

1. Which eye is affected by floater?	RIGHT	LEFT	BOTH			
2. How long have you noticed opacity interfering with your vision?	Less than 3 months	3-6M	6-12M	more than 12 months		
3. Does the floater move?	YES	NO				
4. Do you have difficulty due to the opacity with following activities?						
Driving a car	YES	NO				
Reading	YES	NO				
Working on computer	YES	NO				
Performing near work	YES	NO				
5. How much do you feel bothered by opacity in the daily life?	0	1	2	3	4	5
	Never					All the time
6. Which type of opacity do you see?	ONE FLOATER	MORE FLOATERS				
7. Do you wear dark glasses because of opacity?	YES	NO				

Laser vitreolysis-questionnaire after the treatment

Name and surname ………………………………………………………… **Age** …………

1. How much do you feel bothered by opacity in the daily life?

0 1 2 3 4 5
Never--All the time

2. Do you feel improvement after the treatment?

0 1 2 3 4 5
Yes strong improvement ---No improvement

3. **Would you undergo the treatment again?**
YES NO

Figure 3. Vitreous floaters symptom questionnaire

dical, Australia). Targeting of energy propagation was set with the aid of offset – posteriorly in the case of localisation of the floater in the anterior part of the vitreous body, closer to the lens, and anteriorly (more frequently) in the case of localisation of the floater in close proximity to the retina. In the case of long eyeballs, the possibility of more posterior laser propagation, with a higher risk of affecting the retina than in eyeballs of ordinary length, was taken into consideration. The average number of applied laser pulses was 229 ±90.85 (range 71–377, median 225). The total used energy was 619 ±255.8 mJ (range 195–1140, median 622.5). The energy of the pulse was within the range of 2.5–5 mJ, and was titrated from lower values to the value when "bubbles" were recorded in the region of the target of the laser beam, with attendant vaporisation of the affected area (Figure 4, 5). During the procedure it is necessary to consider the energy of the pulse and its distribution, in which it applies that the stronger the energy of the pulse, the further the distribution from the target area. Focusing of the retinal capillaries or optic nerve papilla indicates that the distance to the retina is too close, with the risk that it could be affected upon application of energy. By contrast, a sharp floater and blurred background indicates a safe distance for the laser pulse (Figure 6). The session was concluded after vaporisation of the vitreous floater had been achieved, or after the maximum stipulated quantity of energy (1100 mJ) had been reached. A second session was performed on 8 eyes (9%). 5 patients (6%) underwent a procedure consecutively on both eyes. In 3 pseudophakic eyes from the cohort, pars plana vit-

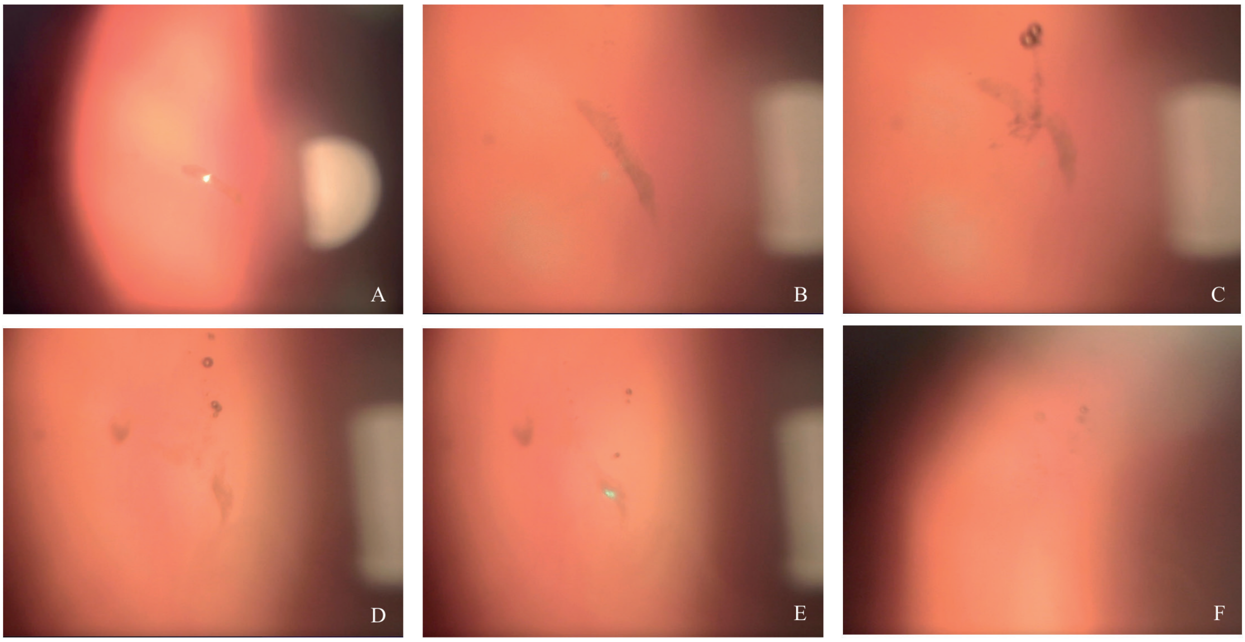


Figure 4. Laser vitreolysis in eye with non PVD type of floater. **(A)** floater **(B)** floater magnified 16x. **(C, D, E)** reduction of floater during the treatment **(F)** photo at the end of the treatment
PVD – posterior vitreous detachment

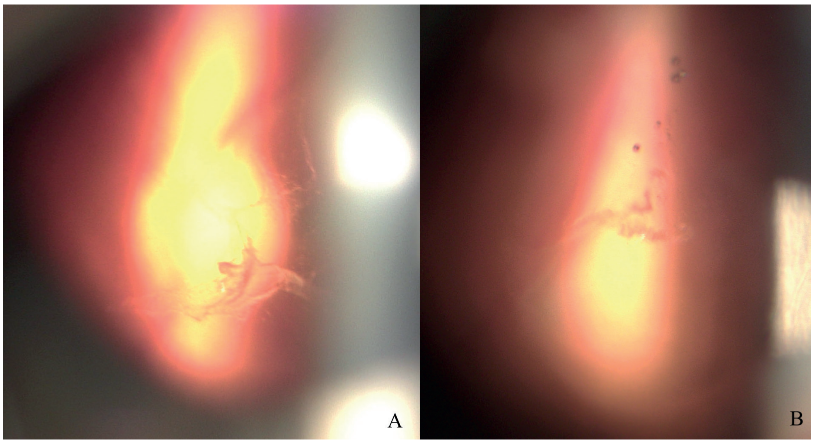


Figure 5. (A) Vitreous floater before optic nerve head. **(B)** Visible formation of bubbles during the treatment

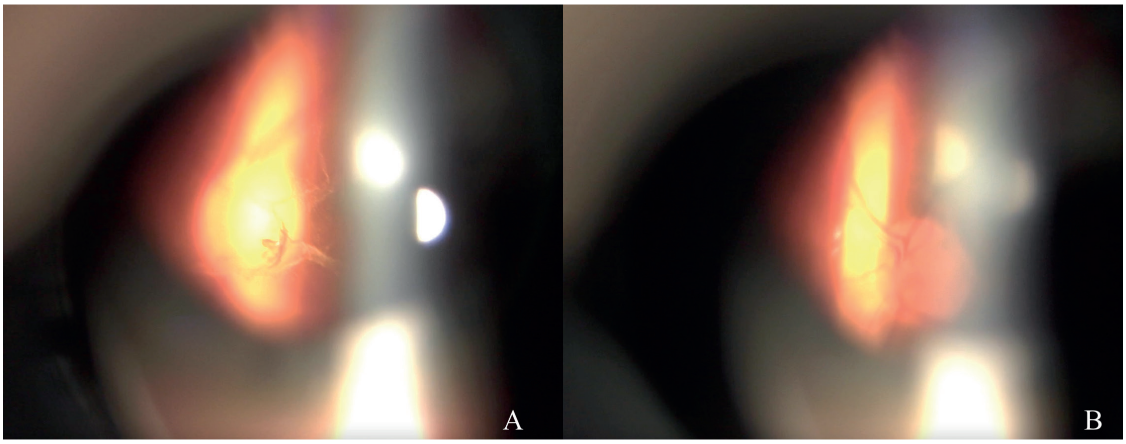


Figure 6. Optimizing of safe distance from retina during the treatment. **(A)** Weiss ring is clear, optic nerve head and retinal vessels are blurred = safe distance. **(B)** Optic nerve head and retina vessels are clear – near distance to retina

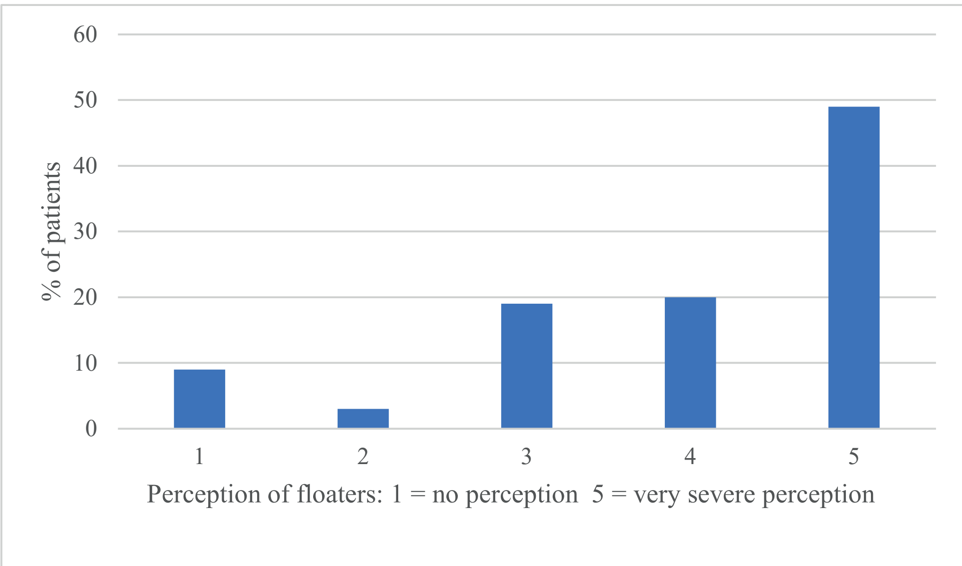
rectomy was indicated during the follow-up observation period due to residual opacities and the patients' wishes to undergo the procedure.

RESULTS

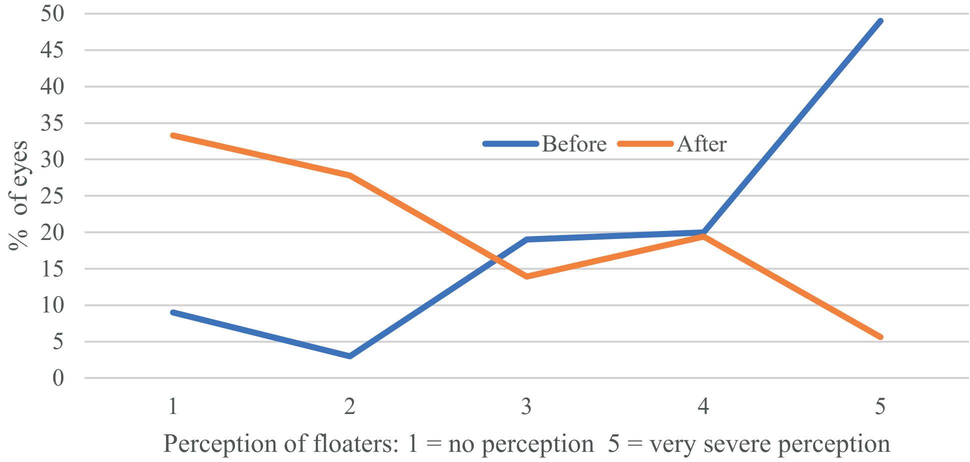
The average age of the patients in the cohort was 63.2 ±10.7 years (range 40–80 years, median 63 years), with a slight predominance of women (53% women). In 46% of cases a Weiss ring-type floater was present, in 54% of cases a different type of opacity was diagnosed. No secondary ocular pathology was found in any of the patients.

Before the procedure, 49% of patients stated complaints persisting for more than 12 months, 28% of patients for 6–12 months and 23% of patients for 3–6 months. Patients with a shorter duration of complaints were not indicated for the procedure. 65% of patients stated complaints when working on a PC or close up, 67% of patients when reading and 43% when driving a motor vehicle. Graph 1 states the degree of impairment on a scale of 1–5 (5 = severe impairment, 1= no impairment). A value of either severe impairment (no. 5) or impairment (no. 4) was stated by 69% of patients. 60% of patients stated an incidence of multiple floaters. 98% of patients did not use dark glasses in order to reduce complaints.

After the procedure, 41% of patients stated a pronounced improvement of complaints (9% complete improvement, 33% almost complete subjective resorption of floater), 33% stated an improvement, but still perceived opacity, 17% did not notice an improvement and 8% were not satisfied with the result whatsoever. Graph 2 states the degree of impairment by the floaters before and after the procedure on a numerical scale of 1–5 (5 = severe impairment, 1= no impairment). 87% stated that they would undergo the procedure again. The improvement score between the group of patients with PVD and non-PVD type floater was not statistically significantly different ($p = 0.4$). The total used energy and number of pulses was lower in the group with PVD type floa-



Graph 1. Subjective perception of vitreous floaters before treatment



Graph 2. Subjective visual impairment by floaters before and after the treatment

ters, although the difference was not statistically significant.

No perioperative complications of the type of retinal haemorrhage or hitting of the lens were observed during the procedure. During the follow-up period (7–29 months, median 13 months) no postoperative complication was observed of the type of retinal tear, retinal detachment, elevation of intraocular pressure, formation or progression of cataract. At the postoperative examination intraocular pressure was 16.25 ±3.19 mmHg, and the value did not differ significantly from the value before the procedure ($p = 0.29$). Best corrected distance visual acuity after the procedure was 0.97 and did not differ from the values before the procedure ($p = 0.82$).

DISCUSSION

The incidence of vitreous floaters may have a significant impact on patient quality of life. Webb et al. [12] used a questionnaire in order to evaluate the incidence of vitreous floaters in users of smartphones. Out of 603 respondents, 76% perceived vitreous floaters, of whom 33% stated that they significantly impaired vision. Kim et al. [13] report a degree of psychological alteration influencing perception of floaters, in which people with depression and anxiety have tendencies to perceive the incidence of vitreous floaters as a severe impairment. References to the use of an Nd:YAG laser for the purpose of performing laser vitreolysis can be found in publications from 1993 onwards. The authors used a rather smaller quantity of energy, and the results of subjective improvement are very variable. A randomised prospective trial using the same type of laser was published in 2017 [2]. The cohort comprised 52 patients, of whom 36 were treated with laser vitreolysis, while 16 underwent only a placebo session. 53% of patients stated a pronounced or complete reduction of opacities, by contrast with 0 % of patients stating an improvement in the placebo group. In a retrospective study [1] of 55 eyes which underwent laser vitreolysis, reduction of opacity was evaluated according to the NEI VFQ-25 subjective questionnaire, and the shadow of the floater was evaluated according to IR photography. Almost 64% of floaters showed a significant reduction of surface area, and 56% of patients stated satisfaction with the procedure. Souza [14] evaluated the effect of vitreolysis in 32 eyes on the basis of a subjective questionnaire and colour photography of a fundus with opacity. He reported an improvement according to an objective evaluation in 94% of cases, in which in 56% of eyes the photograph was evaluated as complete lysis of the floater, and in 37.5% as partial. However, in a subjective evaluation only 46% of patients stated an improvement of the finding. Best corrected distance visual acuity was without change, while visual acuity of patients for reading recorded a significant improvement.

Complications during and after the procedure

The number of documented complications following the procedure is less frequent. The most commonly stated are transitional elevation of IOP, opacities of the posterior capsule, secondary glaucoma, hitting of the retina and minor retinal haemorrhages, retinal cracks with subsequent detachment and CME. Studies published by Noristan [15] and other authors [16, 17] describe the incidence of cataract as a consequence of laser vitreolysis upon unintentional distribution of energy anteriorly in front of the required target in the vitreous body, when the targeted floater was located in close proximity to the lens. Hahn [18] reports incidence of cataract, elevation of IOP and injury to the retina as the main complications of the procedure. In his report he describes 2 cases of affliction of the posterior capsule of the lens, with the need for subsequent removal of the lens. This is based on the voluntary database of reports of complications of the American Society of Retina Specialists Research and Safety in Therapeutics over a period of 6 months. A total of 16 reported complications were registered. However, the total number of performed procedures during this period is not known. Sun [1] describes affliction of the retina in 1 case ($n = 55$), in which the patient was prescribed general glucocorticoids in order to suppress inflammatory reaction and improve micro-circulation, as well as vitamin C in order to reduce oxidative stress. Singh [19,20] retrospectively evaluated 300 eyes, with incidence of an undesirable occurrence at less than 1%. Of the aforementioned complications this concerned elevation of IOP, damage to the lens or affliction of the retina. Retinal detachment did not occur in any case within the cohort. Jihan Louh [21] in a study published in 2018 observed a cohort of 30 Chinese patients, in which over the course of 6-month observation he did not record an elevation of intraocular pressure in any patient. Direct damage by laser beam is the subject of a report by Shields [22], who describes affliction of the retina with vitreous haemorrhage and subsequent branch retinal vein occlusion. A second described patient developed a retinal tear requiring laser retinopexy, with subsequent temporal scotoma on the perimeter. Direct affliction of the posterior pole of the retina may cause permanent damage to vision.

Used quantity of energy

In the first mentions of laser vitreolysis [23], a regular laser designated for the removal of secondary cataract was used. The quantity of used energy for the removal of vitreous floaters was stated at 1.2 mJ, which could have been associated with the lower effectiveness of the procedure, with patient satisfaction stated at only 2.5%. Lin [7] in his study reports the energy range used within the limits of 5–9 mJ, and a 70% success rate of the procedure. Shah [2] and Ludwig [24] state pulses within the range of 3–7 mJ and 4–7.2 mJ, with a success rate of 53 and 77% respectively. In the presented cohort the energy used was 2–5 mJ. In our cohort we observed the first 25 eyes after one day and after one month, in which we did not encounter any cases of elevation of intraocular pressure. We are therefore continuing to conduct follow-up examinations on the patients at an interval of 1–3 months as standard.

The type of floater may play a significant role in the options for its removal and the effect of treatment. In the professional literature, floaters are most commonly divided into PVD and non-PVD type floaters, with some studies reporting a higher success rate of the procedure primarily in the case of patients with a Weiss ring [2,23,24]. In a study dividing patients with PVD and non-PVD floaters [7], authors report a similar success rate in both groups (72.7% in the PVD group and 69% in the non-PVD group, $p = 0.344$) regardless of the type of floater. This is in accordance with the findings for our presented cohort, in which no statistically significant difference was found in subjective evaluation following the procedure between PVD and non-PVD type of floater.

CONCLUSION

Nd:YAG laser vitreolysis appears to be a potential method for the management of vitreous opacities in subjectively symptomatic patients, above all thanks to the non-invasive nature of the procedure and low incidence of complications in connection with the procedure. A limitation of this and other studies published to date remains the objectification of the success rate of the method of laser vitreolysis and its correlation with subjective patient satisfaction. A further limitation of the use of this method is the distance of the floater from the lens and retina. The method is also appropriate for solitary rather than diffuse floaters.

REFERENCES

1. Sun X, Tian J, Wang J, Zhang J, Wang Y, Yuan G. Nd:YAG Laser Vitreolysis for Symptomatic Vitreous Floaters: Application of Infrared Fundus Photography in Assessing the Treatment Efficacy. J Ophthalmol. 2019 Jan 27;2019:8956952.
2. Shah CP, Heier JS. YAG Laser Vitreolysis vs Sham YAG Vitreolysis for Symptomatic Vitreous Floaters: A Randomized Clinical Trial. JAMA Ophthalmol. 2017 Sep 1;135(9):918-923.
3. Yonemoto J, Ideta H, Sasaki K, Tanaka S, Hirose A, Oka C. The age of onset of posterior vitreous detachment. Graefes Arch Clin Exp Ophthalmol. 1994 Feb;232(2):67-70.
4. Shah CP, Fine HF. Management of Floaters. Ophthalmic Surg Lasers Imaging Retina. 2018 Jun 1;49(6):388-391.
5. Nguyen JH, Nguyen-Cuu J, Yu F. et al. Assessment of Vitreous Structure and Visual Function after Neodymium:Yttrium--Aluminum-Garnet Laser Vitreolysis. Ophthalmology. 2019 Nov;126(11):1517-1526.
6. Milston R, Madigan MC, Sebag J. Vitreous floaters: Etiology, diagnostics, and management. Surv Ophthalmol. 2016 Mar-Apr;61(2):211-227.
7. Lin T, Li T, Zhang X. et al. The Efficacy and Safety of YAG Laser Vitreolysis for Symptomatic Vitreous Floaters of Complete PVD or Non-PVD. Ophthalmol Ther. 2022 Feb;11(1):201-214.
8. Son G, Sohn J, Kong M. Acute symptomatic vitreous floaters assessed with ultra-wide field scanning laser ophthalmoscopy and spectral domain optical coherence tomography. Sci Rep. 2021 Apr 26;11(1):8930.
9. Appeltans A, Mura M, Bamonte G. Macular Hole Development After Vitrectomy for Floaters: A Case Report. Ophthalmol Ther. 2017 Dec;6(2):385-389.
10. Karel I. Indikace pars plana vitrektomie [Indications for pars plana vitrectomy]. Cesk Oftalmol. 1989 Mar;45(2):65-70.
11. Rubino SM, Parke DW 3rd, Lum F. Return to the Operating Room after Vitrectomy for Vitreous Opacities: Intelligent Research in Sight Registry Analysis. Ophthalmol Retina. 2021 Jan;5(1):4-8.
12. Webb BF, Webb JR, Schroeder MC, North CS. Prevalence of vitreous floaters in a community sample of smartphone users. Int J Ophthalmol. 2013 Jun 18;6(3):402-5.
13. Kim YK, Moon SY, Yim KM, Seong SJ, Hwang JY, Park SP. Psychological Distress in Patients with Symptomatic Vitreous Floaters. J Ophthalmol. 2017;2017:3191576.
14. Souza CE, Lima LH, Nascimento H, Zett C, Belfort R Jr. Objective assessment of YAG laser vitreolysis in patients with symptomatic vitreous floaters. Int J Retina Vitreous. 2020 Jan 21;6:1.
15. Noristani R, Schultz T, Dick HB. Cataract formation after YAG laser vitreolysis: importance of femtosecond laser anterior capsulotomies in perforated posterior capsules. Eur J Ophthalmol. 2016 Nov 4;26(6):e149-e151.
16. Koo EH, Haddock LJ, Bhardwaj N, Fortun JA. Cataracts induced by neodymium-yttrium-aluminium-garnet laser lysis of vitreous floaters. Br J Ophthalmol. 2017 Jun;101(6):709-711.
17. Sun IT, Lee TH, Chen CH. Rapid Cataract Progression after Nd:YAG Vitreolysis for Vitreous Floaters: A Case Report and Literature Review. Case Rep Ophthalmol. 2017 May 29;8(2):321-325.
18. Hahn P, Schneider EW, Tabandeh H, Wong RW, Emerson GG; American Society of Retina Specialists Research and Safety in Therapeutics (ASRS ReST) Committee. Reported Complications Following Laser Vitreolysis. JAMA Ophthalmol. 2017 Sep 1;135(9):973-976.
19. Singh IP. Modern vitreolysis-YAG laser treatment now a real solution for the treatment of symptomatic floaters. Surv Ophthalmol. 2020 Sep-Oct;65(5):581-588.
20. Singh IP. A retrospective study on the safety of YAG laser vitreolysis for the treatment of symptomatic floaters. Poster presented at: AAO. New Orleans: Louisiana; 2017

21. Luo J, An X, Kuang Y. Efficacy and safety of yttrium-aluminium garnet (YAG) laser vitreolysis for vitreous floaters. J Int Med Res. 2018 Nov;46(11):4465-4471.
22. Shields RA, Cheng OT, Ruby AJ, Williams GA, Wolfe JD. Retinal Complications after Yttrium-Aluminum-Garnet Laser Vitreolysis for Vitreous Floaters. Ophthalmic Surg Lasers Imaging Retina. 2021 Nov;52(11):610-613.
23. Delaney YM, Oyinloye A, Benjamin L. Nd:YAG vitreolysis and pars plana vitrectomy: surgical treatment for vitreous floaters. Eye (Lond). 2002 Jan;16(1):21-6.
24. Ludwig GD, Gemelli H, Nunes GM, Serracarbassa PD, Zanotele M. Efficacy and safety of Nd:YAG laser vitreolysis for symptomatic vitreous floaters: A randomized controlled trial. Eur J Ophthalmol. 2021 May;31(3):909-914.