WHITEPAPER

EXPANDING POSSIBILITIES: TREATING FLOATERS WITH LASER VITREOLYSIS

FEATURING: ALLAN J. WHITEHEAD, MD AND DR. PETER LAGOUROS, MD

In the past, vitrectomy has been commonly considered the gold standard for the treatment of debilitating floater symptoms, but the risk of complications means that it may not be suitable for all patients. Under such circumstances, minimally invasive laser vitreolysis provides a viable option to eliminate the visual disturbances caused by floaters. This approach is virtually pain-free and does not carry the same risks of infection, bleeding or retinal detachment that comes with vitrectomy. Dr. Allan J. Whitehead, MD and Dr. Peter Lagouros, MD share their experiences of laser vitreolysis using the Ultra Q Reflex laser (Ellex, Australia, www.ellex.com).

Floaters occur because the properties of the vitreous change. The vitreous is an avascular body made up of a fine network of collagen cross links with water that is surrounded by hyaluronic acid. This helps create a negative charge that inhibits collagen clumping. If there is a loss of hyaluronic acid, the collagen within the vitreous will begin to clump and aggregate. As collagen clumping increases, the water is squeezed out to create a lacuna that allows these opacities to float. The vitreous may detach from the tight attachment at the optic nerve or separate from the internal limiting membrane posterior to the vitreous base. As changes in the vitreous progress, the potential for posterior vitreous detachment (PVD) increases.

Asteroid hyalosis, another condition causing significant floater symptoms, occurs where calcium-lipid complexes form in the vitreous. This condition affect 0.5-0.9% of the population.[1] All of these conditions may cause symptomatic floaters.[2]

Floaters are common in the general population, estimated by one study at 76%. Some 33% in this study reported that the floaters were significant enough to cause noticeable visual impairment.[3]

Karickhoff, one of the original pioneers of laser vitreolysis, noted that floaters had a psychological consequence as well as an objective reduction in best visual acuity (BVA) or increase in glare. He argued that the severity of floater symptoms was determined not only by the properties of the floater (i.e. the mass, the distance from the retina and the visual axis) but also by an anxiety component[4].

Despite relatively good BVA, patients may still experience a decreased health-related quality of life due to symptomatic floaters. Using time-trade off (TTO) and standard gamble (SG) measures to determine clinical utility, Wagle reported that in a study of 311 outpatients that floaters had the same negative impact as age-related macular degeneration on quality of life. The study also showed that younger patients with symptomatic floaters were more likely to seek treatment and accept the associated risks for vitrectomy[5]. Zou, et al., confirmed the negative quality of life impact caused by floaters in a study published two years later[6].

VITRECTOMY: THE GOLD STANDARD?

While floaters are often easy to overlook as a common symptom of vitreous deterioration, the adverse impact that they can have on a patient’s quality of life is sometimes significant enough to warrant treatment. In such cases, pars plana vitrectomy has been offered as a “definitive” treatment.[7]

The procedure provides an effective means of the elimination of floater-related symptoms, leading to substantial improvements in stray light and contrast sensitivity measurements, as well as improved quality of life for patients.[7,8] Vitrectomy is extremely effective in removing floater symptoms, since the vitreous is removed entirely. In one study, it fully resolved symptoms in 93.3% of patients.[2] Another study noted that symptoms were completely resolved in 84% of patients and an additional 9.3% of patients had a reduction in symptoms.[9] However, like other invasive surgical procedures, vitrectomy carries various risks that need to be considered on an individual patient basis before the procedure is performed for the treatment of floater symptoms.

One of the most frequently discussed risks associated with vitrectomy is the development of cataracts.[10] One recent study noted that 96% of patients undergoing 20-gauge pars plana vitrectomy (PPV) developed at least mild lens changes, while 72% of eyes undergoing small (23 or 25) gauge PPV had mild lens changes after three years. After 20-gauge PPV, 41% of patients required cataract extraction, while 42% of small gauge PPV needed cataracts removed.[11] Based on his experience, Dr. Whitehead states that the vitrectomy procedure is an assured catalyst for the development of cataracts in phakic eyes, speeding up the process of lens opacification even in younger patients.

Other potential complications of vitrectomy include retinal tears and detachments, as well as endophthalmitis, vitreoretinal hemorrhages, glaucoma and macular edema.[11] In one study of 110 eyes, retinal detachment occurred in 10.9% of eyes. Cystoid macular edema developed in 5.5%, while epiretinal membranes occurred in 3.6%. In 0.9% of cases, postoperative scotoma, macular hole, and secondary glaucoma requiring surgical treatment occurred.[9] An additional study showed that suprachoroidal hemorrhages happened in 0.4% of patients, choroidal detachments in 0.4%, vitreous hemorrhage in 1.5%, and hypotony in 0.2% of patients. As with any vitreoretinal surgery, there is a risk of endophthalmitis. One retrospective study analyzed the risk of this potentially sight-threatening side effect and found that the rate of occurrence was 0.039%.[15]

However, for many patients, resolving the severe symptomatic effects of floaters substantially outweigh the adverse effects of potential intra- and post-operative complications. Additionally, recent technological developments have led to a reduction in the rate of complications. Vitrectomies are ideal for patients with multiple floaters that are dense or large enough that they require an invasive procedure for elimination according to Dr. Whitehead. Where there are alternative non-invasive options for floaters that are smaller and lighter, it would be advisable to pursue these, since they entail less risk of complication. Dr. Lagouros argues, “Vitrectomy has a limited role in removing floaters because of the potential complications.” However, he asserts that if patients are significantly affected by floaters, and they fully understand and accept the risks of complications, then vitrectomy would be a suitable treatment method.

ANOTHER CHOICE: LASER VITREOLYSIS

Laser vitreolysis offers an additional option for the treatment of floaters without the risks associated with vitrectomy. A minimally invasive procedure, laser vitreolysis can safely eliminate the visual disturbances caused by floaters using a modified nano-pulsed YAG laser, as offered by Ultra Q Reflex (Ellex, Adelaide, Australia). The laser emits a brief, small burst of energy. The 3 nanosecond,
8 micron energy pulse creates a potent power density of 109 J/cm^2. The energy vaporizes the floaters, converting the hyaluronic and collagen molecules into a gas, which is then resorbed by the eye.

With a tight focus of the laser onto the anterior floater surface and appropriate energy levels, the floater breaks down into plasma. This physical process is called optical breakdown. After optical breakdown occurs, any additional laser energy propagates back from the plasma zone towards the laser source. This is the focal convergence zone. During the ablation process, the floater becomes opaque. It reflects light for approximately 20 to 30 nanoseconds. This reflection shields the retina and any other posterior structures from the laser energy. The wide focusing angle of 16 degrees allows surgeons to make sure that optical breakdown occurs at the appropriate focal plane.

As the floater is lysed, gas bubbles are released. These bubbles are visible to both the surgeon and the patient. Surgeons will see these bubbles moving upwards, while patients will perceive these as sinking down. The gas bubbles will dissolve and be resorbed approximately 10 to 15 minutes after treatment. Some of the collagen remnants may disperse throughout the vitreous. These may need further laser treatment to decrease or eliminate floater symptoms.

Younger patients typically have a vitreous that still has a strong attachment to the retinal interface. An obvious posterior vitreous detachment reduces the retinal traction. Higher amounts of traction translate into a higher risk for retinal detachments during vitreous procedures, so it is critical that laser energy does not propagate throughout the vitreous. Previous generations of Nd:YAG lasers (neodymium-doped yttrium aluminium garnet) had larger spots sizes that did not allow the plasma burst to be as tightly focused, so vitreolysis was more difficult with the older lasers.

Since the Ultra Q Reflex laser places the target illumination, treatment beam, and the surgeon's vision in the same optical pathway, the surgeon can be more confident about targeting floaters without fear of damaging the lens or retina. The optical breakdown and small convergence zone created by this laser minimizes plasma movement and energy levels needed for ablation.

Reported complications and side effects from vitreolysis are rare when using a Nd:YAG laser designed for posterior segment use. The procedure provides a high degree of patient satisfaction, and it leaves the option of a pars plana vitrectomy open if further floater reduction is needed.

In one study comparing vitreolysis with pars plana vitrectomy, both groups experienced vision improvement. The vitreolysis group noted an 80% improvement and the vitrectomy group reported a 90% improvement. There were no complications in the vitreolysis group during the eight-year follow-up period.[17]

Despite limited published findings, compelling evidence shows very low complication rates with laser vitreolysis. For instance, in a study of 1500 patients, Karickhoff[4] reported that the adverse event profile was 0.1%. The study also showed that treatment was effective in 75-95% of patients. Furthermore, Geller showed a similar success rate (85%)[18], with no report of post-treatment complications such as retinal detachments, hemorrhages, holes or vitritis.

PHYSICIAN EXPERIENCE AND PATIENT SELECTION

Laser vitreolysis has yielded effective results and high patient satisfaction at various clinical sites. Dr. Whitehead has treated more than 300 patients using laser vitreolysis with great success, while Dr. Lagouros has achieved significant success following his early experiences with the device.

In Dr. Whitehead's experience, the ideal patient for laser vitreolysis needs to have reasonable expectations: "They must know that there is a chance that I can greatly reduce the size or presence of their floater, but I may not eliminate it in its entirety." Part of having reasonable expectations is also having the understanding that it may take a second session of vitreolysis treatment in order to eliminate the visual disturbances caused by a floater. While laser vitreolysis offers effective treatment of such floaters, he notes that it cannot treat all types of floaters. Vitrectomy would be more effective in treating multiple large and dense floaters compared to laser vitreolysis, since it would take too much power and time to eliminate these floaters using the laser. However, patients with smaller floaters are well suited for laser vitreolysis, and in Dr. Whitehead's experience, about three quarters of all patients that are significantly bothered by floaters are candidates for laser vitreolysis.

Dr. Lagouros adds that the ideal candidate for laser vitreolysis should have "somewhat small, discrete floaters" that are located fairly posteriorly in the vitreous, so that they are easy to target. He also notes that large, membranous floaters cannot be treated with laser vitreolysis due to the high laser energy required to ablate them. For those patients with small floaters and appropriate expectations, however, laser vitreolysis offers a good option of floater removal with a much lower complication rate.

One of the main benefits of laser vitreolysis over vitrectomy is the significantly lower risk factor. Unlike vitrectomy, laser vitreolysis does not pose the risk of any significant risk of bleeding or infection. The risk of theoretical risk of cataract development is negligible, and the procedure does not require general anesthesia. Due to the very low risks, Dr. Lagouros places laser vitreolysis "at the safe end of the risk spectrum" compared to vitrectomy, since complications are scarcely a concern if the procedure is conducted appropriately and with precision. Furthermore, in uncomplicated cases, it is usually quicker to perform a laser vitreolysis procedure than it is a vitrectomy, which offers benefits to both patient and doctor. Moreover, there is no significant recovery period involved with the vitreolysis procedure, enabling superior postoperative patient comfort since it does not entail multiple postoperative follow-ups to ensure that there are no complications with intraocular pressure (IOP), bleeding or detachment. Additionally, as Dr. Whitehead points out, the cost of a laser vitreolysis procedure is far lower than the cost of a vitrectomy.

There are very few risks with the Ultra Q Reflex laser in both doctors' experience, which demonstrates the safety of the laser vitreolysis procedure. The system features an energy profile of a narrow, ultra-Gaussian beam, a fast-pulse rise time of 4 nanoseconds, and a small spot size. This keeps the dissipated energy within the vitreous lower and offers a smaller convergence zone. The laser produces a 180 micron zone with 5mJ and a 250 micron zone with 20mJ, which is a non-linear rise. This means that clinicians can use a higher power density and fewer shots, thereby delivering less cumulative energy to the patient. The retractable reflecting mirror and coaxial illumination allows excellent viewing of the vitreous in order to precisely locate and target the problematic floaters.[19]

TREATING FLOATERS WITH LASER VITREOLYSIS

To date, neither Dr. Whitehead nor Dr. Lagouros has experienced any significant complications with their patients. Naturally, potential risks can occur if the laser energy is applied inadvertently to another part of the eye, such as the retina, a blood vessel or the posterior lens capsule, but these risks can be prevented through the careful targeting of the laser.

When he first started performing laser vitreolysis nearly 10 years ago, Dr. Whitehead was somewhat skeptical about the procedure. This was in part due to the limitations of the technology of the time, which meant that there were many more reasons for patient exclusions. During these early years of experience, Dr. Whitehead only performed the procedure on pseudophakic eyes, and only on floaters that were relatively immobile and not positioned too posteriorly. He was reluctant to treat floaters that were hypermobile, since they would often prove time-consuming to chase and target. While still maintaining a high level of cautiousness today, Dr. Whitehead is now more comfortable treating floaters that are hypermobile because of the technical capabilities of the new Ultra Q Reflex laser. Similarly, Dr. Whitehead was initially hesitant about treating hazy or membranous areas that were more difficult to define, but now he is confident in treating these areas by breaking them up into smaller pieces so that they no longer disrupt the patient's vision. This transition for Dr. Whitehead is largely the result of the development of the Ultra Q Reflex, which enables more accurate results with improved visualization and a tolerance range of ± 8 µm, as well as offering low energy levels for safer laser delivery. In turn, this increased Dr. Whitehead's confidence in targeting floaters without being concerned about inadvertently applying the laser energy to other parts of the eye. Overcoming his initial skepticism was also partially the result of improving patient communication, enabling realistic patient expectations that the procedure may not remove a floater completely, but rather enable its breakdown and dispersal to an acceptable level.

CLINICAL PEARLS FOR SUCCESS

Dr. Whitehead emphasizes the importance of the doctor-patient relationship as a central aspect of treatment success: "I must be in absolute agreement with my patient that the particular bothersome floater that they have is the one that I am seeing and describing to them." He believes that it is a collaborative process, where the doctor and patient work together in identifying the floater before entering the laser room, by matching descriptions of the floater's appearance and the direction in which it moves. Once patient and doctor agree on these descriptions, they can be sure that the correct floater has been identified. Furthermore, Dr. Whitehead says that he maintains patient communication throughout the procedure. He talks to the patient periodically, asking what they are seeing or experiencing, and explains what he is doing at every step. This helps to maintain a high level of patient comfort as well as to sustain the collaborative element of the procedure.

In terms of patient selection, Dr. Lagouros finds that the contact lens that is designed to be placed on a patient's cornea during laser vitreolysis can also be helpful in determining which patients are good candidates for the procedure itself. The recommended lenses (Karickhoff Vitreous lenses and the Peyman Wide Field YAG laser lens) offer an assortment of focal lengths that enable an effective way of evaluating the vitreous and visualizing floaters with sharp focus and clear detail. Using this method, Dr. Lagouros has been able to ascertain which patients are ideal for the procedure and which ones are not, depending on the nature and formation of the floaters. Ellex offers a list of recommended lenses for use with their laser.[20]

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ellex.com

Headquarters
82 Gilbert Street
Adelaide, SA, 5000 AUSTRALIA
+61 8 8104 5200

Japan
3F, 3-2-22 Harumi Chuo-ku
Tokyo 104-0053 JAPAN
+81 3 5859 0470

USA
7138 Shady Oak Road
Minneapolis, MN, 55344 USA
800 824 7444

Germany
ZPO floor 1, Carl-Scheele-Str.16
12489 Berlin GERMANY
+49 30 6392896 00

Australia
82 Gilbert Street
Adelaide, SA, 5000 AUSTRALIA
+61 8 8104 5264

France
La Chaufferie - 555 chemin du bois
69140 Rillieux la Pape FRANCE
+33 4 8291 0460