

LFR TECHNOLOGY SPOTLIGHT

Illumination and Laser Energy

BY INDER PAUL SINGH, MD

After performing more than 1,600 laser floater removal (LFR) treatments over the past 4 years, I have come to learn that, to ensure high safety and efficacy, one must use the correct technology optimized for this procedure. All YAG lasers are not created equal. Physicians attempting this procedure in years past were limited by the available technology's illumination system and delivery of energy.

A LESSON IN ILLUMINATION

Traditional Nd:YAG lasers are designed to view and treat structures in the anterior portion of the eye (iris and lens) in order to perform YAG capsulotomies and laser peripheral iridotomies. These lasers deliver their illumination from a low, noncoaxial position, which makes it difficult to clearly visualize the middle and posterior vitreous (regardless of the use of a specialized contact lens), where the bulk of symptomatic floaters reside. If the illumination tower and the ocular/aiming beam/laser delivery are not on the same optical pathway, it is not possible to identify many of the symptomatic floaters people are suffering from. It is not just visualization of the floater that is limited by the noncoaxial position of the laser and light source of conventional Nd:YAG lasers; spatial context, which is vital for safe application of a laser beam in the posterior segment, is also lacking in these lasers. In other words, how do we know where the floater is in relation to the lens and retina? How do we know it is safe to fire and will not risk hitting other ocular structures? These questions can only be addressed by using the correct visualization and energy delivery system afforded by Reflex Technology (Ellex).

The Ultra Q Reflex and Tango Reflex systems (Ellex) allow the laser to be fired with the slit lamp in multiple positions (ie, slit-lamp center [on-axis] or oblique [off-axis]). In the on-axis position, the coaxial illumination allows for a red reflex and the ability to visualize posteriorly to the retinal structures (Figure 1). Clinically, if the floater is in focus and the retina is out of focus, we know we are safe to fire. Conversely, if the floater is anteriorly positioned, we need to make sure we do not hit the lens. Therefore, we can place the slit lamp in the off-axis position, which provides more contrast of the floater by removing the red reflex and allowing better visualization of the posterior capsule (Figure 2). It

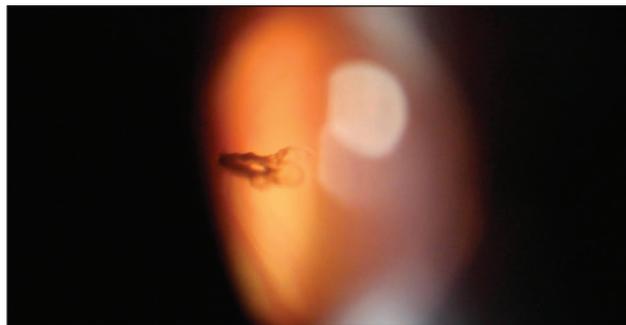


Figure 1. The on-axis mode provides visualization of the middle and posterior vitreous and allows for spatial context, especially near the retina. Red reflex helps provide the necessary illumination to appreciate distance of the floater from the retina and optic nerve.

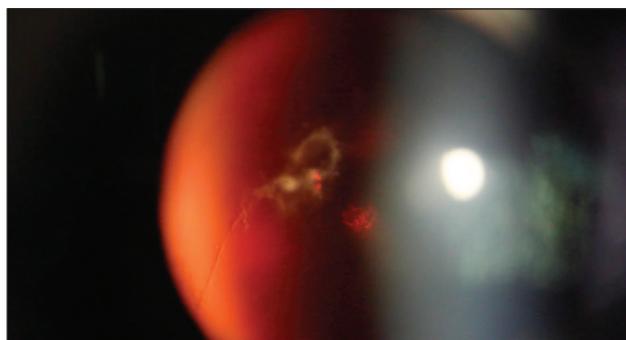


Figure 2. The off-axis mode is beneficial for visualizing anterior floaters, helps to better define the posterior capsule, and decreases glare in some situations. It removes some or all of the red reflex, which allows for some floaters to appear "white" and enhances contrast when needed.

is analogous to visualizing the endothelium of the cornea in our examination rooms; we need to place the slit lamp in the oblique (off-axis) position to visualize the posterior cornea. The ability to fire in any slit-lamp position also allows for titratable illumination. We can titrate the amount of red glow by settling in between on-axis and off-axis mode. For instance, if I have a floater in the middle to anterior vitreous, I may move the slit lamp 10° to 15° off-axis to slightly decrease the glow anteriorly to help provide more contrast to visualize the floater but still provide enough coaxial illumination to give feedback on where the retina

is in relation to the floater. Throughout the procedure, I continually assess the position of floaters using both on- and off-axis modes to ensure constant feedback on spatial context. The ability to permit both visualization and laser firing in multiple illumination settings ensures that, regardless of where a floater is in the eye, and where we want to see in the eye, an appropriate illumination setting is available to provide the spatial context needed.

Part of the learning curve with LFR treatment is feeling comfortable firing the laser without good visualization of the aiming beams. When the floater is in the middle or posterior vitreous and the system is in on-axis mode, the red glow of the fundus can sometimes make it difficult to visualize the aiming beams. If you are confident that you are not near any structures (ie, retina is not in focus, and you are at a zero offset), it is okay to fire at the floater after you have gained more experience. The plasma spark will give you the spatial context of where the laser energy is firing. It is analogous to performing a YAG capsulotomy. Often, it is hard to see the posterior capsule, but when you fire the laser, you are given the necessary spatial context to better identify the posterior capsule. You can also place the system in a partially off-axis position (titrate the illumination) to reduce the amount of red glow to allow for increased contrast, which can help you to visualize the aiming beams and the floaters.

PROPERTIES OF YAG LASER ENERGY

Many of us were not taught much in training about the properties of YAG laser energy in the eye. Through work with LFR, I have come to understand that there is a nonlinear relationship between an increased energy setting on the laser and dispersion of energy in the eye. For instance, at 1 mJ, the size of the convergence zone (energy dispersion in the eye) is approximately 110 μm . Increasing the laser energy to 5 mJ increases the convergence zone to approximately 150 μm . Increasing the energy from 5 to 10 mJ does not double the amount of dispersed energy; instead, it represents an approximately 30% increase (150 to 210 μm). This nonlinear relationship is what allows for increased energy settings to be used during the procedure.

The Ultra Q Reflex features an energy profile of a narrow ultra-Gaussian, 4-nanosecond beam that has a fast pulse rise and fall time and a small spot size. This allows for a more efficient energy delivery and a smaller convergent zone, ie, dissipated energy recoil from the laser within the vitreous. The amount of energy needed to create a plasma spark in air is approximately 40% less with the Ultra Q Reflex and Tango Reflex lasers than with a standard OEM cavity

laser.¹ Traditional YAG lasers typically have larger and less controlled plasma with more inconsistent power output. Since it can be difficult to focus on small structures—such as vitreous strands—collateral ocular tissue damage may occur. Clinically, the truncated energy beam translates to the floaters being vaporized at lower energies, but it also allows the floaters to remain close to the plasma energy after firing the laser (followability). The increased efficiency of the laser energy minimizes the floaters bouncing around the vitreous.

This nonlinearity rise with increasing laser energy provides efficient—yet reassuring—energy characteristics so that I can achieve higher power density and tightly controlled plasma with fewer shots and less cumulative energy being delivered to the patient.¹ It is also why I feel comfortable firing at energy levels upwards of 5 to 6 mJ, which is much higher than most clinicians are used to firing for YAG capsulotomies. This is an important point, because if we fire at lower energy levels (1 to 2 mJ), we will not vaporize the floater; rather, we will push the floater away.

CONCLUSION

Compared to its early clinical use in the 1980s, modern LFR provides more efficient and safer energy profiles—offering reliable and repeatable outcomes that provide a low rate of complications, combined with a high degree of patient satisfaction.^{2,3} YAG lasers were traditionally only equipped for capsulotomy and iridotomy procedures and thus were not optimized to visualize structures behind the lens. With recent improvements in technical design, however, specially designed multimodality YAG lasers—such as the Ultra Q Reflex and Tango Reflex—can now be used to perform LFR with a higher degree of safety and efficacy than their traditional counterparts.¹ I am still amazed how much of a positive impact this procedure has on patients' daily functioning. We have trained ourselves and trained our patients for years to ignore this condition, but once I started performing this procedure, I was able to appreciate the need to treat these patients. ■

1. Data on file. Ellex Medical Pty Ltd.

2. Fankhauser F, Kwasniewska S, van der Zygen E. Vitreolysis with the Q-switched laser. *Arch Ophthalmol*. 1985;103(8):1166-1171.

3. Levy JH, Pisacano AM. Clinical experience with Nd: YAG laser vitreolysis in the anterior segment. *J Cataract Refract Surg*. 1985;13(5):548-550.

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