The Yellow Wavelength

High-Power Minus Collateral Damage

Featuring insight from David Dyer, MD, Retina Associates, USA; Sharon Fekrat, MD, Associate Professor, Duke University Eye Center, USA; and Professor Michael Stur, University of Vienna, Austria.

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Absorption and light scatter are just two of the considerations in the delicate relationship between laser and tissue that determine the suitability of a wavelength to a particular ophthalmic procedure. For instance, the most effective wavelengths for macular photocoagulation are those that are poorly absorbed by macular xanthophyll and well absorbed by melanin in the retinal pigment epithelium (RPE) and choroid, as well as hemoglobin. Thus, the selection of the best wavelength for treatment of the macula is a function of the differing light scattering and light absorption properties of the various wavelengths. As a result, use of both the yellow wavelength (561-577nm) and the red wavelength (659-670nm) to perform retinal treatment warrants further investigation.

INTRODUCTION

Retinal specialist David Dyer, MD, Retina Associates, Missouri, USA, explains that when treating inside the macular pigment area, 561nm yellow creates a more predictable, controlled burn than traditional 514/532nm green wavelengths, resulting in low scotoma formation. This, in turn, enables more precise control over the interaction between the laser beam and tissue.

"561nm yellow is suitable for performing all 514/532nm green laser procedures, including iridotomy and laser trabeculoplasty. Compared to 532nm green, 561nm yellow exhibits similar high absorption in melanin and in hemoglobin, which allows for production of visible lesions with low energy settings. In contrast to 532nm, 561nm is not absorbed by xanthophyll, the pigment that is present in the macula and the fovea."

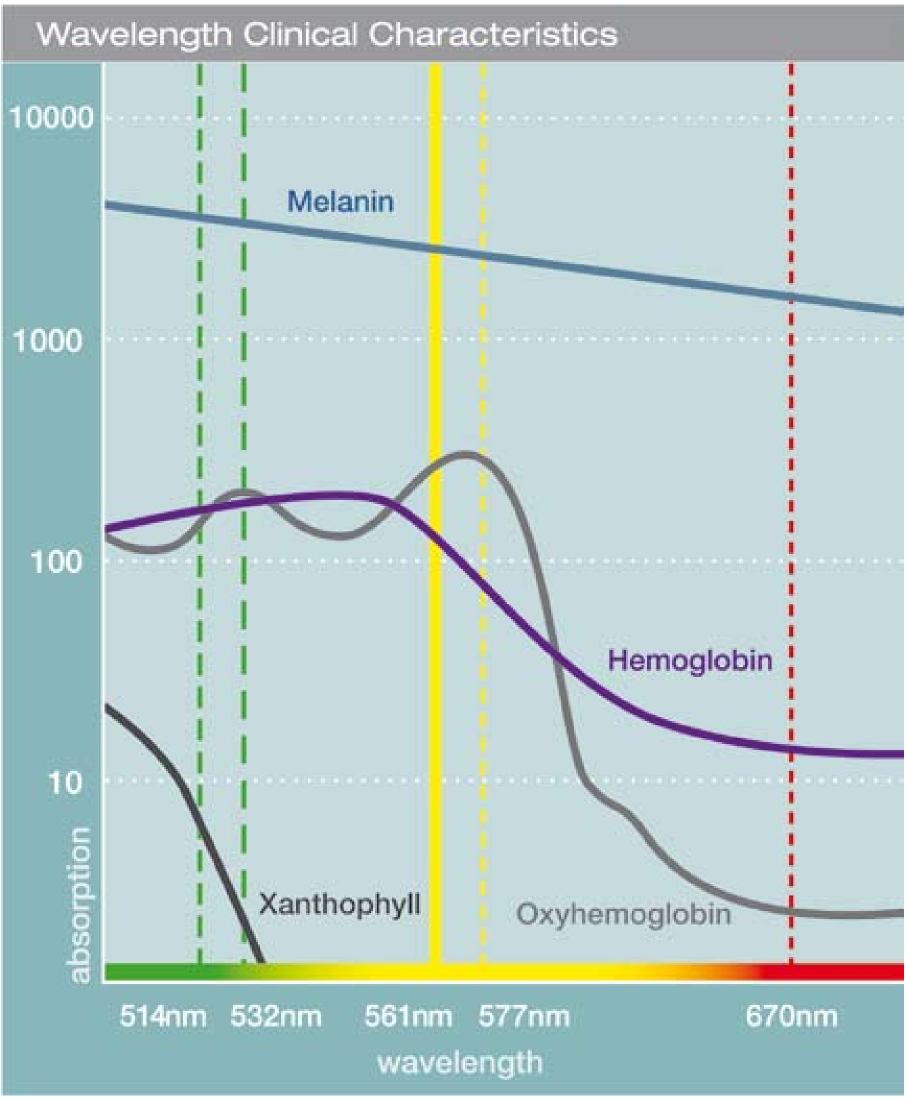
When comparing the use of green and yellow light in ophthalmology, the primary distinction resides here: the yellow wavelength facilitates lighter retinal burns in the target tissue with less energy uptake in the surrounding retinal tissue. In addition, the yellow wavelength can treat the same lesions as the green wavelength, but with a more defined burn with minimal spreading due to the lower energy levels used.

Lower energy output, improved patient comfort, less light scatter and less phototoxicity are among the benefits of the 561nm yellow wavelength, according to Sharon Fekrat, MD, Associate Professor, Vitreoretinal Surgery, Duke University Eye Center, Durham, NC. "One key advantage of the 561nm wavelength is that it can create a visible laser burn with less power and thus less injury to collateral tissues than the green wavelength," says Dr. Fekrat.

Professor Michael Stur, University of Vienna, Austria, agrees. "I have been using the yellow wavelength for many years, and I would agree that it is a very good wavelength for retinal laser photocoagulation. Its main advantage is its high absorption in melanin and hemoglobin, which produces visible lesions with low energy settings. I would not call this "gentle", although it is possible to make very low intensity burns with yellow."

The factors that determine whether a patient experiences pain during retinal laser treatment are power, the laser wavelength absorption and the pulse length or duration. "The use of the yellow wavelength is more comfortable for patients because there is less lateral as well as less axial spread of thermal energy. Because the yellow wavelength is well absorbed, the power and duration can be decreased and thus the patient is more comfortable," explains Dr. Fekrat.

"The main advantage of the yellow wavelength is that yellow is taken up in oxygenated and deoxygenated blood more preferentially than the green wavelength. This means that when we are treating a blood vessel, the yellow wavelength is taken up and it thus requires less energy to affect the vessel without inflicting damage on surrounding tissues," adds Dr. Dyer.



An advantage when treating inside the macular pigment area is that the 561nm yellow wavelength is less absorbed by xanthophyll, says Dr. Dyer. As a result, use of the yellow wavelength may be safer to use when treating microaneurysms or choroidal neovascularization in the peri and parafoveal region. Dr. Fekrat concurs that higher absorption by melanin and hemoglobin and an absence of xanthophyll absorption are important features of 561nm yellow. "High absorption by hemoglobin allows selective treatment of diabetic microaneurysms, and high absorption by melanin is preferred during laser trabeculoplasty (ALT) and peripheral iridotomy," explains Dr. Fekrat.

The yellow wavelength is also an excellent choice to close vessels, such as aneurysms. "Because the 561nm yellow wavelength is absorbed by hemoglobin it is better absorbed

561nm vs. 577nm

Both Dr. Dyer and Dr. Fekrat agree that the two solid-state yellow wavelength technologies available in the marketplace today -- 561nm and 577nm – are comparable, and that based on absorption coefficient charts, clinical differences between the wavelengths and their interactions with various retinal tissues, one can expect similar clinical results and benefits with either yellow wavelength.

561nm does have marginally higher absorption in melanin than 577nm yellow, however, which makes it better suited to standard photocoagulation treatments targeting the RPE. Both 561nm and 577nm are equally efficacious for treatments in and around the macula given that they share the same absorption profile in xanthophyll.

than the 532nm green wavelength by microaneurysms in eyes with clinically significant macular edema due to diabetic retinopathy," says Dr. Fekrat. "The yellow is also ideal to treat hemangiomas, which are vascular and thus contain high levels of hemoglobin," she adds.

The yellow wavelength produces less scatter and thus allows better transmission through lens opacities. In particular, yellow can be used effectively to transmit through lenses with nuclear cataracts. According to Professor Stur, this is a key advantage of 561nm over 532nm. "The significantly reduced scatter of 561nm through lenses with nuclear cataracts allows us to use reduced power settings, but still have enough power to treat the retina."

"Since lens opacities scatter the laser beam, using a wavelength that allows less scatter will, by definition, be more effective in such clinical scenarios," explains Dr. Fekrat. "Like colors go through like colors," adds Dr. Dyer, "so using the yellow wavelength is beneficial for maintaining sufficient power to penetrate a nuclear sclerotic cataract without inflicting damage to the lens."

Ultimately, Dr. Fekrat says, in addition to its other benefits, the yellow wavelength is ideal for treating clinically significant diabetic macular edema and juxtafoveal and extrafoveal choroidal neovascularization, as well as to perform grid pattern laser in eyes with branch retinal vein occlusion. "Also, given its high absorption in melanin, the yellow laser may be considered in the treatment of some eyes with chronic central serous retinopathy because the lack of yellow laser uptake by xanthophyll protects the fovea," says Dr. Fekrat. And finally, she adds, this versatile wavelength "may also be better suited for feeder laser photocoagulation in eyes with retinal angiomatous proliferans."

REFERENCES

1 Mainster MA. Wavelength selection in macular photocoagulation. Tissue optics, thermal effects, and laser systems. Ophthalmology 1986;93:952-8.

2 Mainster MA. Decreasing retinal photocoagulation damage: principles and techniques. Semin Ophthalmol. 1999; 14: 200-209.

3 Meyer-Schwickerath GR. The history of photocoagulation. Aust N Z J. Ophthalmol. 1989; 17: 427-34.

4 Krauss JM, Puliafito CA. Lasers in ophthalmology. Lasers Surg Med 1995; 17: 102-59.

ellex.com

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

Japan
4-3-7 Miyahara 4F, Yodogawa-ku
Osaka 532-0003 JAPAN
+81 6 6396 2250

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

Germany
Edisonstraße 20
3512 Hainburg GERMANY
+49 6182 829 6900

Australia
Suite 2, Ground Floor, 18-20 Orion Road
Lane Cove, NSW, 2066 AUSTRALIA
1800 817 920

Europe Support Center
108, avenue Marx Dormoy
63000 Clermont-Ferrand FRANCE
+33 4 73 34 18 55