COMMENTARY

The Benefits of Dual Wavelength Lasers

Having 532- and 940-nm laser energy available in the same handpiece improves treatment of ectatic and dyschromic lesions

BY JOE NIAMTU III, DM.D.

Figure 2

If a cosmetic surgeon were stranded on a desert island for the past 20 years and suddenly returned to practice, he or she would not believe all the changes that have occurred in aesthetic dermatology and cosmetic surgery in general.

There has been a huge shift in what patients want and what doctors deliver. A generation ago, patients wanted to look tighter; now they want to look younger. A natural look is paramount and key to patient happiness.

By Joe Niamtu III,

Cosmetic surgeons have rethought fat removal and volume replacement, and now realize the importance of volume restoration for youthful rejuvenation. The evolution of facial fillers, Botox, and other "lunchtime" procedures have propelled the office-based cosmetic surgeon into the limelight of minimally invasive cosmetic surgery.

So have advances in laser treatments. Again, a generation ago, the choice of workable and safe wavelengths was small. Other than crude burning, not many helpful or affordable choices were available. Newer devices, especially dual-wavelength lasers, have greatly improved surgeons' ability to treated two important facial problems: ecstatic facial vessels and dyschromias. These generally benign lesions have been treated with many various modalities, including excision, cryotherapy, sclerotherapy, chemical and laser peel, and electrosurgical ablation.

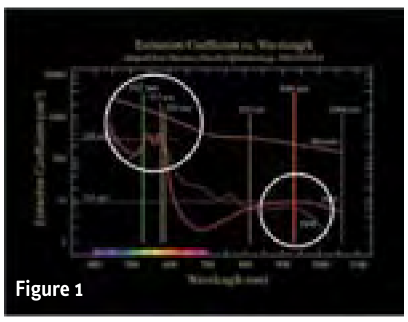

Figure 1

Some of the earliest laser treatments for facial telangiectasias were performed with continuous wave CO_2 (10,600 nm) and argon (488 and 514 nm) lasers. Although successful outcomes have been reported, these lasers destroyed the ectatic vascular tissue as well as the overlying epidermis in a nonselective fashion. These lasers were, in effect, sophisticated forms of electrocautery.

With the understanding selective photothermolysis, the 585-nm pulsed dye laser was developed and quickly became the gold standard for the treatment of vascular lesions of the face. Although this laser was quite effective, it was big and expensive and produced unsightly purpura that were the dread of patients and surgeons alike.

Newer laser technology has led to ultra long pulse 585 nm lasers that eliminate post-laser-treatment purpura, but they, too, are large (over 300 lbs) and expensive. Other lasers such as the copper vapor or argon lasers, again, were big, expensive, and produced lateral tissue damage.

The treatment of ectatic vessels, birthmarks such as port-wine stain, hemangiomas, tortuous veins, and other related facial lesions has been a challenge. The removal of facial telangiectasias and actinic pigmented lesions remain some of the most requested cosmetic facial procedures.

The development of intense pulsed light (IPL) technology enable the use of broadband light with wavelengths between 550-1,200 nm for treating a host of lesions and conditions. By employing cutoff filters, a range of specific wavelengths could be used to simultaneously treat "red and brown" lesions. Although IPL is an effective treatment for red and brown lesions, it is also a big, expensive machine, and takes significant skill on the part of the operator to avoid burns and pigmentation pattern problems. Although the IPL treatment head covers large areas of the face and neck quickly, most patients require four to five treatments to see a significant difference.

LASERS AND HEMOGLOBIN

The primary absorption peaks for oxyhemoglobin are approximately 418, 542 and 577 nm in the visible

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spectrum, and there is a secondary absorption peak at 940 nm in the near-infrared spectrum (Figure 1).

Figure 1, shows the absorption peaks for oxyhemoglobin and a secondary peak close to 940 nm in the near-infrared spectrum. Vessels with oxyhemoglobin are best treated in the 400-600 nm range whereas those vessels with significant reduced hemoglobin are best treated in the 940 nm range.

Thermal relaxation time (TRT) is defined as the time required for an injured target to cool to half of its peak temperature immediately following laser irradiation. Having a pulse duration that is shorter than the TRT of the treated vessel prevents the energy from dissipating too far beyond the targeted vessel. This means that the heat generated by each pulse of the laser is confined to the targeted blood vessels and is dissipated before it can spread to lateral normal tissue. Combining these ideas led to laser technologies that were safe and effective for treating vascular lesions.

LASERS ADVANCE

Enter the solid state diode laser. Just as transistors made vacuum tubes obsolete, semiconductor diode-pumped lasers are replacing vacuum tubes and flashlamp-pumped lasers. Dual wavelength laser systems that produce 532-nm and 940-nm wavelengths are among the latest advances. These systems are lightweight (18 pounds) and portable (they are about the size of a videocassette recorder) and run on standard wall power (Figure 2). The

> These wavelengths make the removal of telangiectasias and pigmented lesions truly a lunch-time procedure.

532-nm wavelength is generated by a high-powered diode laser at 808 nm, which is used to optically pump a Nd:YAG crystal to produce 1064-nm light. This light is then focused onto a potassium titanyl phosphate (KTP) crystal to double its frequency, thus splitting the wavelength in half to produce a 532-nm wavelength.

Having a single laser with both the 532-nm and 940-nm wavelengths is a clinical benefit; the different wavelengths can be used without changing handpieces. The operator simply turns a switch to change from 532 to 940 nm. Spot sizes are available in 0.7, 1.0, 1.4, 2.0 and 2.8 mm (Figure 3A).

Figure 2. The new dual wavelength solid state lasers are compact, lightweight and portable.

Clinicians who have experience with the 532-nm diode laser are familiar with the immediate disappearance of the ectatic vessel after laser-light exposure. The longer 532-nm diode laser pulses heat the blood more gently and damages endothelial cells, but does not burst vessels, as evidenced by the lack of purpura. The 532-nm wavelength, which is strongly absorbed by oxyhemoglobin, is preferred for smaller and more superficial vessels, which can be heated to clinical response temperatures with minimal incident energy. High oxyhemoglobin absorption, however, can limit the depth to which 532-nm laser light penetrates into skin, making it difficult to treat large or deep vessels.

This is where the secondary absorption peak at 940 nm is clinically useful. It is less strongly absorbed by oxyhemoglobin and thus can penetrate more deeply. Thus, the 940-nm wavelength is particularly effective in treating deep or bluish vessels and vessels with significantly reduced hemoglobin, or when absorption by epidermal melanin is a concern. This is a relatively new treatment wavelength that has not been readily available on commonly-used machines.

Figure 3. Figure 3A shows the straight handpiece treating telanigectasia of the nasal rim and figure 3B shows the computer pattern generator in use to treat larger areas in less time.

The dual-wavelength lasers have computer pattern generators (CPG) that produce up to 50 pulses per second. The CPG delivers 700-micron treatment spots that are placed on 875, 1000, or 1170 micron center to center spacing over two-centimeter-square treatment area (figure 3B). This precisely controlled spacing leaves small untreated volumes surrounding each treatment spot. These volumes act at thermal dissipation zones during treatment allowing the use of higher energies in treatment spots for more clinical effect. After treatment, the untreated zones become healing centers distributed throughout the entire treatment area allowing rapid healing and giving maximum rejuvenation similar to the fractionated resurfacing theory.

The patterns give 60, 45, or 30 percent skin coverage per treatment, respectively. For doctors accustomed to the mundane task of tracing individual telangiectasias, the CPG is a welcome implement that allows much faster treatments that simplifies a boring procedure and seem to be less painful to the patient. The CPG has resurfacing capabilities and can also be used for full-face treatments to improve skin blemishes, produce a more uniform skin texture and tone, and treat large lesions such as poikiloderma, port wine stains, and matted telangiectasias. Again, the CPG with controllable spot size, configuration and density facilitates the treatment of large areas including full face (Figure 3B).

RED AND BLUE VASCULAR LESIONS

Modern polarizing filter magnified headlights are an all-in one solution to eye safety, magnified vision, and cross polarization illumination during laser treatment for vascular, pigmented and cutaneous lesions (Figure 2). The integrated eye safety filters use narrowband, color balancing coatings that provide clarity to view and give protection for both the 532 nm and940 nm laser wavelengths. By adjusting the polarizing filter, the glare is removed from the skin with the illusion of "seeing under the skin". This allows the operator to see all vessels much better and to see some vessels that may not be apparent to the naked eye of the doctor or patient.

The most important innovation of this headlight/magnification system, however, is that the orange (or purple) protective eyewear that usually is required with 532 and 940 nm lasers

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is not needed. The built in loupes automatically filter out the respective wavelengths. Not having colored lenses improves visualization of vessels and reduces eye fatigue.

The choice of handpieces is dictated by anatomy and lesion type. For selected smaller telangiectasias, DPN's, lentigos, nevi, and macules, the straight handpiece provides a controlled spot size of various diameters. For larger lesions such as rosacea, poikiloderma, melasma, and generalized facial pigment resurfacing, the CPG is superior and significantly reduces treatment time by "covering more ground." With the single handpieces on the 532-nm mode, vessels are merely traced and the operator watches as they disappear (figure 3A).

It does not seem to make a difference if the laser is started proximally or distally to the ectatic vessel. If a vessel is resistant to the 532-nm wavelength, a flip of the switch changes to the 940-nm wavelength to bring in the big gun.

This handpiece is used somewhat differently. Instead of tracing along the entire vessel as with the 532-nm wavelength, the 940-nm wavelength is used to strike the vessels at varying lengths along the actual vessel. When a given telangiectasia is hit with a 940-nm pulse, it often occludes the vessel several millimeters distally. This means that the vessel can be treated with fewer pulses with this wavelength. For small red lesions a single pass is adequate. For larger red or blue vessels, two passes may be required. The author has treated larger, torturous facial veins with multiple sessions of the 940-nm wavelength.

Figure 3

Figure 4

Figure 5

Figure 6

Figure 4. This patient with severe ectatic facial vessels was treated with two sessions of the 532-nm laser.

Figure 5. The 940-nm wavelength enables treatment of larger, deeper vessels than the 532-nm wavelength. This patient is shown two weeks after a single treatment with the 940-nm wavelength for a dilated periorbital vein.

Figure 6 shows the successful treatment of multiple DPN's on an African-American patient. The smaller lesions were treated with a single treatment and the larger lesions were treated twice.

ANESTHESIA

As the pain sensation is similar to a "rubber band snap" or a Botox injection with a 32-gauge needle, the vast majority of patients presenting for red or brown lesions do not require any supplemental anesthesia. Refrigerated aloe gel provides a heat sink and mitigates the discomfort and is used routinely. Topical anesthetic creams can also be applied. Areas such as the nostrils, alar bases, columellar area, lips, and perioral regions can be very sensitive and supplemental local anesthetic blocks or infiltration can be used to obtund this discomfort.

PIGMENTED LESIONS

The absorption spectrum of melanin includes the ultraviolet, visible, and near-infrared portions of the electromagnetic spectrum. Because of this, virtually every wavelength along the spectrum theoretically can be used to target melanin. Melanosomes are much smaller than blood vessels (10 vs. 100 mm) and a much shorter pulse duration is required compared with telangiectasias. Pigmented lesions such as lentigines, keratoses, ephledes (freckles), and dermatosis papulosa nigra are successfully treated with the 532-nm wavelength. Early hypertrophic scarring and keloids that possess significant neovascularity also are successfully treated. For most macular lesions, such as lentigines, the end point is a uniform gray color and a popping sound that occurs when tissue becomes plasmoid. The pigmented lesions exfoliate over one to two weeks. Larger or thicker lesions may need retreatment until clinical clearing is achieved.

COMPLICATIONS

Despite what laser salespeople say, there is no such thing as a light-based device that cannot burn a patient. Although these small solid state lasers are easy to use, each machine, each wavelength, and each patient is different. From a liability standpoint, it makes good sense to perform a test spot on all patients considered for treatment. This author rarely does this when using the straight handpieces with small spot sizes, as the treatment area covered is relatively precise and limited. Using the scanning handpiece, however, is another matter. This enables the delivery of increased laser energy to larger areas of skin and is more prone to overtreatment. Mild overtreatment will result in crusting that heals uneventfully. More aggressive overtreatment can cause blistering and lead to hypopigmented areas and permanent scarring. Due to such factors as dermal thickness and skin sensitivity, various areas of the face may respond differently to the laser. A fluence that is adequate for the nose may be too aggressive for the skin at the mandibular angle. Again, performing test spots on various areas is the safest bet.

CONCLUSION

The combination of 532-nm and 940-nm wavelength solid state lasers in a single device is a great advantage for outpatient, minimally invasive treatment of various ectatic and dyschromic lesions. These wavelengths make the removal of telangiectasias and pigmented lesions truly a lunchtime procedure. They provide a wide array of treatment options, and are portable, predictable, and safe. Although the 532-nm wavelength has long been a favorite for treating telangiectasias, having the 940-nm wavelength available provides backup for treating resistant larger, deeper, and bluer vessels.

Dr. Niamtu practices in Richmond, VA, and limits his practice to cosmetic facial surgery. He is board-certified in oral and maxillofacial surgery and is, a Fellow of the American Academy of Cosmetic Surgery and the American Society of Lasers in Medicine and Surgery." He can be reached at niamtu@niamtu.com."