Lasers Make Their Marks on Skin and Tissue Procedures

Valerie C. Coffey, Contributing Editor, stellaredit@gmail.com

Light-based aesthetic procedures are advancing from well-established spa-based procedures to trickier problems, such as resistant tattoo removal and treatments for wounds, scars and skin diseases.

Laser hair removal was the number one laser-based nonsurgical procedure for American men and women in 2014 – more than 1.1 million procedures took place. According to an annual report by the American Society of Plastic Surgeons, this number is up 3 percent from that of 2013. Beyond the spa, lasers are becoming a tool of choice for surgeons and dentists, thanks to their abilities to simultaneously cut and coagulate cleanly, reduce pain and improve patient recovery time.

Dermatologists are making progress in new laser therapies to treat skin diseases, scars, burns, and conditions like melasma with less pain and in fewer treatments, not to mention with better-looking results for patients. Laser advances also allow quick and effective removal of various pigments, such as those in tattoos and within other benign skin conditions.

Tattoo removal

The number of tattoo removal procedures increased more than 400 percent in the last decade and will continue to grow. Since the 1970s, doctors have applied carbon dioxide (CO₂) and argon lasers to remove tattoos, which serve to heat the water in surrounding tissue in order to destroy tattoo pigment. This nonselective heating from unpulsed lasers tends to damage skin, leaving scars at the site. Those lasers have advanced in technology, leading to fractional lasers that spread out the power of the beam over a broader treatment area, which helps to control the extent of skin damage.

In recent years, the next generation of tattoo-removal technology has been Q-switched lasers, which brought nanosecond pulse duration at numerous wavelengths. These lasers provided shorter pulse lengths to allow the tattoo ink to absorb the laser energy without harming the skin. A Q-switched Nd:YAG laser can target red ink at both the 592-nm and 1064-nm wavelengths, which then is followed a few minutes later by a Q-switched alexandrite laser at 755 nm to treat blue and green inks. A Q-switched ruby laser at 694 nm then can address the more difficult shades of blue and green inks, and do so with less harm to the skin. Q-switched lasers used at all of these wavelengths also will effectively remove black pigment because they absorb nearly every wavelength of light.¹
High-Resolution 3-D Reconstructions

SBF Imaging – Using SEM and LM to Create

Optimizing Experimental Conditions for STED Procedures

Lasers Make Their Marks on Skin and Tissue Procedures

Advancements Come from Many Directions

Quanta Aesthetic Lasers USA LLC in Golden, Colo., has for the past five years offered the first and only Q-switched tattoo-removal laser system that combines three laser wavelengths: a ruby laser at 694 nm and an Nd:YAG laser at 532 nm and at 1064 nm (Figure 1). The less expensive Q-Plus C series of tattoo removal devices has pulse energy on the skin of up to 1 J at both 694 and 1064 nm, with adjustable repetition rates and nanosecond pulse widths. The Optibeam technology in the Q-Plus C offers a flat-topped, square beam spot and homogenizing optics that spread out the energy across the beam, thereby allowing for a more efficient treatment.

The latest advancement in tattoo removal is picosecond laser technology, which heats up tattoo pigment particles very quickly with laser pulses measuring one-third to three-fourths of a nanosecond. In comparison, Q-switched Nd:YAG lasers have pulse durations ranging from 5 to 10 ns, and Q-switched alexandrite lasers have 50-ns pulses. The very short pulses shatter the pigment particles in a photomechanical effect that exposes the skin to less heat. A thin, gray-colored “frosting” forms on the tattoo as the pigment is removed. The tiny particles then are easily eliminated by the body (Figure 2).

In 2013, Cynosure Inc., based in Westford, Mass., launched the world’s first aesthetic picosecond laser, the PicoSure, featuring an alexandrite laser at a 755-nm wavelength – ideal for darker blue and green tattoo inks, as well as for benign pigmented lesions. Studies found that 80 percent of tattoos could be cleared within two weeks, and that 94 percent were cleared of difficult-to-remove blue and green inks. Earlier this year, the FDA approved clearance for the new, add-on 532-nm wavelength laser for treating red, orange and yellow tattoo inks. Doctors report that yellow ink disappears in one to four treatments.

Quanta also is developing a picosecond laser that already is approved in Europe and, stateside, currently is in the FDA approval process. The dual-wavelength Discovery Pico laser will offer peak power at up to 1.8 GW for a photomechanical effect at 532 nm and at 1064 nm.

“Quanta’s picosecond laser will be more powerful than any other dual-wavelength picosecond medical laser available,” said Niki Sparks, director of marketing and communications for Quanta. “Quanta’s picosecond laser will be more powerful than any other dual-wavelength picosecond laser available.”

In a press release, Roy Geronemus, MD, director of the Laser & Skin Surgery Center of New York commented, “The PicoSure is dramatically different in treating difficult tattoo colors, such as blue and green. PicoSure more rapidly lightens other colors, with improved recovery time due to less collateral injury to the surrounding tissue.” In addition to treating resistant tattoos, the PicoSure 755-nm laser also is useful for treating facial acne scars, striae, aging décolletage and wrinkles. The team combined fractional laser ablation with topical corticosteroid suspension in the postoperative period to flatten scars and greatly improve scar texture (Figure 4). In another study, Waibel followed a course of fractionated CO2 with LED low-level laser therapy to facilitate wound healing. Successful results have obvious and important implications for treating traumatically injured patients with laser and light-based therapy.

Scar and pigment treatment

For years, fractional lasers have been the go-to lasers for scar and burn treatment via ablative laser resurfacing, which creates microscopic wounds on the scale of 100 microns in size – the body quickly heals these on its own. In March, medical and aesthetic laser innovator Lutronic Corp., based in Fremont, Calif., announced what it claims as “the fastest CO2 fractional laser,” – the eCO2. The laser operates at 1064 nm, with pulse rates from 10 to 200 Hz, and a tip with two different sizes: 120 and 300 microns, respectively (Figure 3). A patented dynamic mode allows the system to paint fractionated points like an airbrush for faster treatments and natural-looking outcomes.
“The fractional laser is really quite revolutionary,” said Waibel. “A lot of our scar patients have had thousands of surgeries and were sent home and told they’ll have to live with their scars. Lasers have really been a game changer in scar treatment.”

In other skin treatments, fractional lasers work well on brown pigments but generally are not effective for redness. For treatment of red and purple pigments associated with pediatric vascular birthmarks, such as port-wine stains, the most commonly used laser is the pulsed dye laser (PDL), which ranges from 585 to 595 nm with cryogen spray cooling. The PDL can be effective on skin phototypes from I to IV. Other lasers used for capillary malformations include frequency-doubled Nd:YAG, alexandrite and diode lasers.

At Beckman Laser Institute at the University of California, Irvine, professor of dermatology and surgery, Kristen Kelly, MD, is at the forefront of new laser techniques and treatments for vascular skin conditions, particularly for patients with darker skin types in which melanin blocks the treatment from reaching the targeted blood vessels. Kelly and colleagues combined the use of traditional PDLs with a custom, 664-nm continuous wave laser, talaporfin sodium (NPe6) and photodynamic therapy (PDT). Talaporfin sodium is a photosensitizer with selective vascular effects that researchers use to treat port-wine stains.

Traditionally, port-wine stain treatments can require 20 or more sessions, which are painful and less effective in patients with darker skin types. In China, alternative PDT protocols require patients to stay out of the sun for two to four weeks after each treatment, and treatment durations can be long. In preclinical work, Kelly's team found that they could reduce the time it takes to shut down the blood vessels to 10 to 20 minutes, and the investigational medicines enable a shorter sun-restriction period of three to ten days. Additional studies are using antiandrogenic agents posttreatment to prevent recurrence of blood vessels.

“We do get the blood vessels to go away, but they regrow. It’s two steps forward, one-and-a-half steps back,” said Kelly.

Now in the early clinical trial stage, Kelly’s work with her colleague, Bernard Choi, uses laser speckle imaging to demonstrate that the newly proposed treatments can reduce blood flow after treatment (Figure 5). Dual PDT plus PDL phototherapy represents a novel approach to effective treatment of port-wine stains for patients of all skin types, resulting in fewer treatments and reduced postoperative photosensitivity.

“Our goal is to enable patients with port-wine stains to be more confident in their relationships and interactions with the world,” said Kelly.

References


