Palomar Q-YAG 5™ Clinical Update Number One

Optimizing Treatments with the Palomar Q-YAG 5 System

The introduction of the Palomar Q-YAG 5 Laser System provides new opportunities for the treatment of tattoos and pigmented lesions. The shorter pulse duration and resultant higher peak power of the laser has produced excellent clinical results. A flatter beam profile causes significantly less damage to the epidermis, which in turn minimizes the risk of post-operative problems. In fact, the improved beam quality may actually pose a dilemma to many users because there is less visual change to the skin to demarcate the previously treated area. However, a unique feature of the Q-YAG 5 offers a solution to this potential dilemma, as we shall see.

All Q-switched, flashlamp-pumped, solid-state lasers (Nd:YAG, ruby, alexandrite) produce multi-mode output pulses of light. The temporal profile (the peaks and valleys of the pulse energy over time) and the spatial profile (a cross-section of the beam, which may be hotter in some places than others) determine the overall quality of the laser pulse. Temporal spikes or spatial hot spots can cause undesirable clinical effects on the skin. Most commonly, such effects include pinpoint bleeding or tissue ablation at the point of impact.

Previously manufactured Q-Switched Nd:YAG lasers (QSYL) delivered multi-mode pulses in the 5-7 nanosecond range, with a spatial profile of a Guassian shape. Guassian beams have a very sharp spike or peak in the center of the beam and consequently have a much higher fluence at this peak. The peak-to-average ratio of the Guassian beam is approximately 4:1, meaning the center spike is four times higher than the base of the beam. Therefore, the useable spot size of the laser beam is much smaller than the spot size set on the laser control panel or the laser hand piece.

For example, the ConBio Medlite II laser offers a 4 mm spot size and is set at approximately 3.2 – 3.5 mm. The actual useable energy is closer to 2.5 – 3.0 mm. The next generation QSYL was the ConBio Medlite IV, which featured an improved beam profile. In this laser, the beam's spatial profile was a series of rings with a peak to average ratio of 2:1. Clearly, this was a significant improvement over the previous technology, but tissue ablation and pinpoint bleeding were still evident.

In both lasers, as is evident in other articulated arm delivery systems, any inhomogeneity or irregularity in the beam is accentuated by the internal mirrors. A beam delivery system must be designed on the optical deck of the laser to move or manipulate the beam into the proper angle as it enters the articulated arm.

As most users already know, this alignment is both critical and difficult to maintain, especially if the laser is moved. Even slight misalignment will accentuate beam inhomogeneities, and the longer the beam path from the output optic of the laser resonator to the site of impact on the skin, the more likely the beam's spatial and temporal profiles will be marginalized and deliver a less than perfect laser pulse to the tissue.

The Palomar Q-YAG 5 has eliminated the above-mentioned beam problems by introducing an innovative laser-resonator handpiece with a short cavity and direct delivery system. There is no seven-mirror articulated arm to complicate the delivery of the light. The entire laser is constructed inside the handpiece, which can be used either freehand or left attached to the support arm. The proximity of the output aperture to the skin permitted Palomar to eliminate 22 optical surfaces in comparison to the previous technologies.

The shorter cavity enabled the engineers to design a system that produces a shorter, higher peak power output pulse, but equally important, the direct delivery design produces an output pulse with a peak-to-average spatial profile of 1.1:1 (*top hat profile)*. Within an allowable margin of error, this beam profile is perfectly "flat." A flat beam profile causes significantly less tissue ablation and pinpoint bleeding than the beam profiles mentioned above, and results in less whitening of the skin.

The direct delivery design yields another significant advantage over the previous technology. Because

there is less “whitening” of the skin, some users have commented that they have a harder time seeing the treated area. The Q-YAG 5, though, offers a special solution to this observation. The frequency doubling crystal in this laser is located in front of, and in direct alignment with, the output coupler of the laser resonator. Aside from the fact that this design increases the efficiency of the frequency doubling process, it also permits the user to “tune in” whatever percentage of green light is desirable for the application. Therefore, if the user wishes, he or she can dial in just enough green light to produce a slight “whitening” of the epidermis in any circumstance, which in turn creates a clear demarcation of the area of treatment.

For example, if the user is treating a tattoo for the fifth or sixth time, there is usually little tattoo pigment left and the user has a hard time determining what areas have been adequately treated. But with the Q-YAG 5, the user need only “tune in” a small portion of the green (532 nm) light to produce some epidermal effect.

Because the KTP crystal is in-line with the resonator, the total fluence delivered to the site remains constant. As can be clearly seen on the front panel of the Q-YAG 5, the fluence reading remains constant even if the user turns the wavelength choice wheel completely to the right, where the output is 50% 532 nm light and 50% 1064 nm light. This new treatment technique makes the laser more user-friendly and delivers a more precise output pulse where it is most needed.

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