light on lasers

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The right light

Alexandrite laser a versatile tool for a variety of dermatologic applications

First mined from the Ural Mountains in Russia and purportedly named for the young Czar Alexander II, alexandrite is a chameleon-like gemstone that changes color depending on ambient light. Daylight produces an emerald green hue, while incandescent light generates a raspberry-red shade.

Like the stone that sits at its core, the alexandrite laser is a versatile instrument that has many applications in dermatology. Jewelers have used the gemstone for more than a century, but it was not until the 1990s that it was used for medical conditions.

In 1997, the Food and Drug Administration approved the 755 nm alexandrite laser for hair removal. The 755 nm wavelength falls at the very edge of the near infrared spectrum, with a preferential absorption by melanin over hemoglobin. Due to its depth of penetration and its affinity for melanin, lasers utilizing this crystal are among the most widely used.

Tattoo removal

Although the quality-switched ruby laser (694 nm) was first used to treat tattoos, the Q-switched alexandrite 755 nm laser is similarly absorbed by tattoo pigment and can be used to treat dark-colored body art. The 755 nm wavelength is less well-absorbed by melanin compared to the 694 nm, but the longer wavelength penetrates more deeply into the skin, so there is less risk of post-procedure hypopigmentation (Leuenberger ML, Mulas MW, Hata TR, et al. *Dermatol Surg*. 1999;25(1):10-14).

Utilizing the principle of selective photothermolysis, the pulse duration of the Q-switched alexandrite laser is 50 to 100 nanoseconds, which allows the laser energy to be confined to the tattoo particle (approximately 0.1 micrometer) more effectively than a longer-pulsed laser. Immediately after treatment, gray-whitening of the skin occurs, followed by erythema and edema. The reaction is color-dependent, with darker colors producing more whitening than lighter colors. Q-switched alexandrite lasers perform exceptionally well when removing black, blue and green tattoos.

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Hair removal

The long-pulsed alexandrite laser can be effective for permanent hair removal. The typical settings employed include pulse durations of 2 to 20 milliseconds and fluences of 10 to 40 J/cm^2. All hair-removal procedures are performed using cooling to protect the epidermis while heating the hair shaft and surrounding follicular structure. It is effective for treating dark hair safely in patients of Fitzpatrick types I – III, and perhaps light-colored type IV skin.

Some studies have shown that this laser can be used safely in darker skin types, including Fitzpatrick types IV-VI (Garcia C, Alamoudi H, Nakib M, et al. *Dermatol Surg*. 2000;26(2):130-134). As with other hair-removal lasers the treatment endpoint is perifollicular erythema. Extreme caution is recommended in tanned patients, as melanin in the skin can act as a competing chromophore, resulting in hypopigmentation or scarring.

Pigmented lesions

The Q-switched and long-pulsed alexandrite lasers can treat a variety of pigmented lesions effectively:

- Lentigines can be treated with the Q-switched alexandrite laser in most skin types. The target melanosomes are 0.5 to 1.0 micrometers, with a thermal relaxation time of approximately 250 to 500 nanoseconds. Therefore, the Q-switched version of the alexandrite laser is most appropriate for selective photothermolysis. In Fitzpatrick types III and IV, lower fluences should be employed to diminish the risk of post-inflammatory hyperpigmentation (Wang CC, Chen CK. *J Dermatol Treat*. Epub ahead of print, 14 July 2011). We recommend treating patients darker than this with Q-switched 1,064 nm Nd:YAG lasers. The endpoint is similar to that seen in laser tattoo removal; immediate whitening that results from rapid heating of the target chromophore and subsequent gas formation. The lentigines will typically darken over five to seven days and then fade away. An absolute contraindication to treatment with any Q-switched laser wavelength is a history of gold therapy, as this can result in laser-induced chrysiasis.
- Café au lait macules (CALMs) can also be successfully treated with the Q-switched alexandrite laser. Wang et al treated 48 Chinese patients (Wang Y, Qian H, Lu Z. *J Dermatolog Treat*. Epub ahead of print, 31 July 2011) and reported relatively high efficacy in removing CALMs, as 26 patients (51.4 percent) had good to excellent responses after an average of 3.2 treatments and with a low rate of recurrence (10.4 percent).
- Becker's nevus can be treated by using the long-pulsed alexandrite laser (Choi JE, Kim JW, Seo SH, et al. *Dermatol Surg*. 2009;35(7):1105-1108). The investigators reported successful treatment with fluences of 20 to 25 J/cm^2, 3 ms pulse duration, and spot sizes of 15 to 18 mm. Becker's nevi are difficult to treat because the pigment originates

deep in the skin within the hair follicle, but the longer pulse duration allows for adequate targeting and treatment of the chromophore. Many times, treatment of the dark hair within the Becker's nevus using a long-pulsed Alexandrite laser results in an acceptable cosmetic result without even treating the pigmentation.

■ Nevus of Ota has been treated with the Q-switched alexandrite lasers for many years. Recently, a large-scale retrospective study of 806 patients with three-year follow-up was conducted (Liu J, Ma YP, Ma XG, et al. *Dermatol Surg.* 2011;37(10):1480-1485) utilizing fluences of 3.8 J/cm^2 to 4.8 J/cm^2, a 3 mm spot and 50 ns pulse. Overall, 93.9 percent of patients achieved complete clearance after an average of 5.2 sessions.

■ Vascular lesions — port wine stains: Port wine stains are often treated with the pulsed dye laser (PDL), but over time port wine stains can become unresponsive to the PDL, and nodules develop. These recalcitrant vessels can be treated with the alexandrite laser that targets both deoxyhemoglobin and oxyhemoglobin chromophores. Moreover, the 755 nm wavelength affords an increased depth of penetration than other wavelengths used for vascular lesions such, as the 532 nm potassium titanyl phosphate and 595 nm PDL (1 mm to 2 mm depth). Reports indicate that the long-pulsed 755 nm laser can be useful for hypertrophic and treatment-resistant port wine stains in adult and pediatric patients (Izikson L, Nelson JS, Anderson RR. *Lasers Surg Med.* 2009;41(6):427-432).

■ Basal cell carcinoma: A recent report (Ibrahimi OA, Sakamoto FH, Tannous Z, et al. *Lasers Surg Med.* 2011;43(2):68-71) suggests the use of the long-pulsed alexandrite laser in helping to reduce the tumor burden in basal cell nevus syndrome. The long-pulsed alexandrite laser targets the oxyhemoglobin in blood vessels and penetrates deeply. In this report of a single patient, there was an 83 percent (15 of 18 basal cell carcinomas) clinical clearance, without histological evidence of residual tumor. Although this represents a single case, it does offer an alternative therapeutic modality for this challenging condition.

Safety

As with all lasers, proper protective eyewear must be worn by patients, practitioners and staff. Special care is indicated when treating periorbital targets such as port wine stains, hair and pigmented lesions. One look at the photo of the ovoid, distorted pupil of a 33-year-old woman on the cover of the March 2007 issue of *Archives of Dermatology* underscores this point (Hammes S, Augustin A, Raulin C, et al. *Arch Dermatol.* 2007;143(3):392-394). Protecting the eyes with gauze and aiming the long-pulsed 755 nm laser away from the orbit were the safety measures used instead of intraocular shields while treating a PWS, and the results were devastating.

A more recent report of the long-pulsed alexandrite laser causing irreversible pupil damage in the ophthalmology literature (Lin CC, Tseng PC, Chen CC, et al. *Graefes Arch Clin Exp Ophthalmol.* 2011;249(5):783-785) underscores this point.

Although the 755 nm alexandrite is a relatively young wavelength in dermatologic laser surgery, its effectiveness and versatility make it a highly attractive option in a laser surgeon's armamentarium. DT