

Use of the KTP Laser in the Treatment of Rosacea and Solar Lentigines

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ABSTRACT

Numerous techniques have evolved in facial plastic surgery to treat rosacea and solar lentigines. The treatment regimens range from avoidance of causative factors to the use of topical agents or other modalities that target the superficial layers of the skin. Of the modalities that target the epidermis, lasers offer the physician and patient the ability to target specific chromophores in the skin. Advances in laser technology led to the implementation of targeting certain characteristic pigments of abnormal areas with minimal damage to surrounding normal tissue. Rosacea and solar lentigines have characteristic cells that are targeted by a potassium-titanyl-phosphate (KTP) laser. The lesions are different in their origins but share the ability to be treated successfully with the KTP laser. A review of both conditions and other treatment options is discussed.

KEYWORDS: Potassium-titanyl-phosphate laser, rosacea, solar lentigines

SOLAR LENTIGINES

Solar Effects on the Skin

Ultraviolet irradiation has many adverse effects on the skin, including skin cancer, sunburn, and photoaging. An individual's risk for accelerating photoaging correlates with baseline pigmentation. The Fitzpatrick classification system stratifies individuals into six skin types based on their skin color and reaction to sun exposure. It has become a useful tool for correlating skin type with skin cancer risk and response to photoaging therapy. Fitzpatrick skin types I and II with baseline minimal pigmentation are at particular risk for photoaging.

Actinically damaged or photoaged skin, also known as dermatoheliosis, is morphologically and histologically distinct from non-solar-exposed aged skin. Aged

skin that has received minimal sun exposure is thin with reduced elasticity but smooth and unblemished. In contrast, photoaged skin contains wrinkles, uneven pigmentation, brown spots, and a leathery appearance. The main differences can be found in the dermal connective tissue where ultraviolet irradiation causes damage. The histological change is a disorganization of the collagen fibrils and the accumulation of abnormal elastin-containing material.¹ The alterations include reduced levels of type I collagen, type III collagen precursors,² and collagen cross-links.³ Additionally there is an increased ratio of type III to type I collagen⁴ and an increased level of elastin.⁵ The exposure to ultraviolet irradiation also leads to increases in matrix metalloproteinases that degrade collagen and may contribute to aging.⁶ Dermal hemosiderosis from actinic purpura can occur as well as solar lentigines.⁷

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Clinical Characteristics

Solar lentigines, also known as old-age spots or liver spots, appear as flat, oval, evenly pigmented macules in areas of chronic sun exposure. Solar lentigines are among the most common benign lesions of the skin. The lesions are often described as tan- to brown-colored macules. The most common areas affected are the dorsum of the hands, shoulders, back, and the face. The hyperpigmentation may vary from light to dark brown but is uniform within the individual lesion. The clinical appearance of solar lentigines at times may be similar to the lentiginous portion of melanocytic neoplasms or lentigo maligna, resulting in a tendency to excessively biopsy a benign process. However, missing an early melanoma has more severe consequences.⁸

Microscopic Characteristics

Solar lentigines are made up of collections of very active melanocytes producing dense melanin pigment in their associated keratinocytes. The features of solar lentigines are mostly limited to the epidermis and, although there is a great deal of melanization of the epidermis, the number of melanocytes is not increased irrespective of skin color. The solar lentigo is a localized focus of highly active melanocytes that results in a focal hyperpigmentation of keratinocytes.

Treatment Options

No treatment is necessary for solar lentigenes. However, if cosmetic removal is desired, treatment options include topical agents, such as a light freeze with liquid nitrogen, the application of hydroquinone for bleaching, or chemical peels. Short freeze times are used to avoid hypopigmentation with liquid nitrogen, which necessitate multiple procedures. The hydroquinone (3 to 4%) can result in some lightening of the solar lentigines, but the results are less than acceptable. The concentration and duration of therapy are usually limited by the side effects. They consist of irritation, depigmentation, and exogenous ochronosis. Phenol and trichloroacetic acid peels have been used for treatment of solar lentigines. However, the side effects include hyperpigmentation, hypopigmentation, scarring, persistent erythema, and, with phenol, cardiac arrhythmias. Another topical solution, tretinoin, has shown very favorable results in the lightening of facial solar lentigines.

The use of lasers in the treatment of pigmented lesions began in the 1960s by Goldman^{Q1}. Numerous lasers can be currently used to treat pigmented lesions, including red light lasers (ruby, alexandrite) and green light lasers (510-nm pulsed-dye, 532-nm frequency-doubled Nd:YAG). The wide range of treatment options stems from the broad absorption spectrum of melanin. The argon laser, which contains green and blue light

(488 and 514 nm), is specifically absorbed by melanin. However, because it is a continuous-wave laser, the heat production causes thermal damage, which can lead to scarring and hypopigmentation.⁹

The goal of laser treatment is to target the pigmented lesion without causing disruption of the normal surrounding tissues. Short laser pulses can be used in a wide range of visible light wavelengths. Pigment-specific lasers can be subdivided into three main groups: green, red, and near infrared. The red and near-infrared systems can be pulsed or Q-switched systems. The green light lasers do not penetrate as deeply, secondary to the shorter wavelength, but are effective in treatment of epidermal pigmented lesions.¹⁰

Green light pulsed lasers produce energy with pulses that are shorter than the thermal relaxation time of the melanosomes. The pulsed-dye (510 nm) and the frequency-doubled, Q-switched Nd:YAG (532-nm) lasers have produced excellent results. However, oxyhemoglobin absorbs the green wavelength, which may cause purpura formation. The purpura usually resolves within 1 to 2 weeks and resolution or lightening of the lesions within 4 to 8 weeks.¹¹ The green pulsed lasers do not penetrate very deeply and are ineffective for treating dermal pigmented lesions.

There are two red light pulsed lasers that had been used for pigmented lesions: the Q-switched ruby (694 nm) and the Q-switched alexandrite (755 nm). The longer wavelengths allow deeper penetration into the dermis. The mechanism of action involves selective photothermolysis, photoacoustical mechanical disruption, and chemical alteration of the melanin-containing melanosomes and melanocytes. These lasers can also treat epidermal lesions without the purpura because of the lack of hemoglobin absorption at the higher wavelengths. The major advantage of the red light lasers over the green light lasers is the treatment of dermal pigmented lesions, such as congenital nevi.¹² The near-infrared pulsed laser, such as the Nd:YAG, produces a wavelength of 1064 nm. Although not as well absorbed by melanin, the ability to penetrate deeper into the dermis has an advantage. By definition, solar lentigines are located in the epidermis; therefore, lasers that penetrate into the dermis have the potential to injure normal cells.

Recently, the potassium-titanyl-phosphate (KTP; 532-nm) laser has been used with success in the treatment of solar lentigines. Treatments are performed in the office and can be completed in minutes without significant discomfort. Topical anesthetic cream is rarely needed but can be used without adversely affecting the treatment. Patients who are Fitzpatrick I to III can expect the best outcome because the pigmented lentigines starkly contrast to those fair skin types. In the event that a fair-skinned patient has a suntan, we counsel these patients to return following dissipation of their tan. We

Q1

do treat skin types IV, and occasionally V; however, they are at increased risk for epidermal injury. The skin pigment chromophores compete with the solar lentigines, absorbing a significant amount of the laser energy. Therefore, darker-skinned patients are treated more conservatively, often requiring multiple treatments. However, they can expect a modest and cosmetically satisfactory improvement. Skin preparation is not necessary other than removing all topical preparations. A parallel cooling device may be helpful in darker-skinned patients by providing added protection to the epidermis. In our practice, we do not routinely use the cooling device. Our preference is a 2-mm hand piece and low energy settings. Each lesion is treated separately with one pass. Immediately following treatment the lesion appears ashlike with a circumferential area of erythema. Patients are instructed to avoid makeup for 6 to 12 hours and not to expose the area to sun. Rarely, a blister may form, more likely in a darker-skinned or tanned patient. Should a blister form, patients are instructed to not puncture it. If it ruptures then topical antibiotic ointments are recommended. Permanent hyperpigmentation, hypopigmentation, and permanent scarring are possible but, to our knowledge, have yet to be encountered in our practice. Most people feel comfortable returning to their routine schedule within a few hours. Over the next week, the lesion transiently becomes darker before beginning to fade. Occasionally, the lesion will slough off in the 2nd week. Subsequent treatments are spaced 2 to 4 weeks apart and are necessary to further fade the lesions. Most people are satisfied after three treatments. Results continue to improve over a 3-month period of time. Posttreatment maintenance includes a detailed skin care regimen and sunscreens (Figs. 1–6).

ROSACEA

President Clinton as well as 13 million other Americans are affected by rosacea. The word rosacea is derived from the Latin word rosaceus, meaning “rosy.” Rosacea is a chronic, acneiform disorder that is characterized by vascular dilation of the central face, including the nose, cheek, eyelids, and forehead. The goal of current therapies is control rather than cure.

Clinical Characteristics

Generally associated with people of Celtic or Scandinavian ancestry, rosacea has an inverse relationship with increased epidermal pigmentation.¹³ Thus, rosacea is uncommon in the African-American population. The population between 30 and 60 years of age is most commonly affected.

The cause of the vascular dilation is not known. Patients affected by rosacea have increased numbers of hair follicle mites, such as *Demodex folliculorum* and



Figure 1 Solar lentigines patient A. Right oblique view pretreatment.

D. brevis.¹⁴ However, other studies have not shown decreases in mite populations despite improvement of rosacea symptoms.¹⁵

Clinical features are characterized by periods of exacerbation and remission. The spectrum of the clinical findings can vary from recurrent flushing episodes to

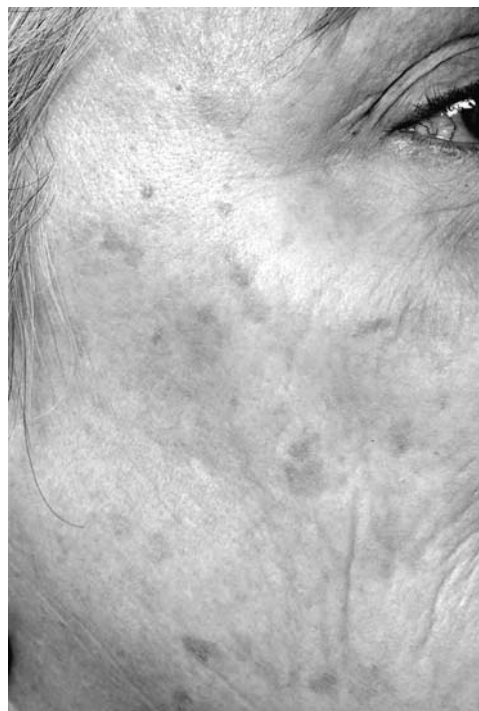


Figure 2 Solar lentigines patient A. Right oblique view posttreatment.



Figure 3 Solar lentigines patient B. Frontal view pretreatment.

rhinophyma. The recurrent flushing, or stage I, may be provoked by a variety of stimuli, including alcohol, spicy foods, and emotional moods. The facial erythema, or stage II, is particularly evident on the nose and cheeks.



Figure 5 Solar lentigines patient C. Left oblique view pretreatment.

Telangiectasias are observed to affect the cheeks. These symptoms may worsen with heat exposure. Patients with worsening rosacea may develop severe sebaceous gland growth, characterized by pustules, papules, nodules, and



Figure 4 Solar lentigines patient B. Frontal view posttreatment.



Figure 6 Solar lentigines patient C. Left oblique view posttreatment.

cysts. The lesions can be very similar to those of acne vulgaris, but there is a lack of a comedone in rosacea.

In patients with rosacea, 20 to 58% develop ocular symptoms that may occur in combination with skin symptoms.¹⁶ The eye findings include foreign body sensation, telangiectasia, blepharitis, keratitis, conjunctivitis, meibomian gland dysfunction, and irregularity of the lid margin. Rhinophyma, or stage III, is hyperplasia of the soft tissue of the nose and usually occurs in middle-aged men.¹⁷

Treatment

The treatment of rosacea is based on managing the symptoms rather than a complete cure of disease. The initial therapy should be patient education and the use of sunscreens, mild cleansers, and avoidance of irritants. Topical antibiotics are the first choice to relieve the inflammatory lesions of rosacea. Metronidazole can be used with or without oral antibiotics to decrease the lesion counts by as much as 60%.¹⁸ Other topicals that have been used with varying amounts of success are azelaic acid, sulfacetamide, clindamycin, erythromycin, and benzoyl peroxide. The agents should be used for at least 4 to 6 weeks before assessing the results.

When the symptoms of rosacea persist, despite topical therapy a stronger treatment is required such as tretinoin cream. The treatment with this medication starts with application at bedtime two or three times per week and increasing the frequency to nightly. Oral antibiotics are used in combination with tretinoin if the disease is recalcitrant or if symptoms of nodular rosacea or ocular symptoms occur. Oral antibiotics that have shown usefulness are tetracycline, erythromycin, and minocycline. Dermabrasion and carbon dioxide lasers can be used to surgically treat advanced rhinophyma.

Intense pulsed light (IPL) has been used with some success in the treatment of rosacea. IPL, with filters bracketing the visible light spectrum, emits light energy that is absorbed superficially in the epidermis and dermis by pigmented melanin and hemoglobin chromophores. The heat deposited within the dermis works in three different ways, the first being to initiate a sub-clinical wound-healing response leading to a repair mechanism of fibroblast activation and collagen remodeling. The second is the displacement of actinically damaged dermis. The third is cytokine activation leading to secondary collagen remodeling via heat shock protein vascular endothelial modulation.¹⁹

The KTP laser, which targets the chromophore hemoglobin, is particularly effective at treating rosacea. The most prominent telangiectatic lesions characteristic of rosacea are treated first. Vessels between 1 and 3 mm respond well to the laser. Laser spot-size diameters and pulse widths are adjusted to match the vessel size. For example, if the vessel diameter is 3 mm, then a

spot size of 3 mm is chosen. With increasing vessel diameter, the pulse width is also increased, depositing energy over a longer period of time. Significant advances had been made over previous laser methods. The earlier pulse-dye laser treatments of telangiectatic lesions involved the use of ultrashort pulse widths in the nanosecond range. These lasers deposited a large amount of energy in a short period of time, often leading to vessel rupture and purpura formation. Therefore, pulse-dye lasers are no longer a first choice for telangiectatic or rosacea treatment.

Prior to treatment, the skin is washed of all debris and topical preparations. Discomfort from the procedure is minimal and pretreatment with topical anesthetic cream is not necessary. Additionally, prilocaine, common to many topical anesthetics, may cause vasoconstriction, which would be counterproductive. Our preference is for parallel cooling of the skin, which not only protects the epidermis from injury when higher energies are used but also provides hypoesthesia. The vessel is viewed through a chilled window within a sapphire tip. The vessel is traced and treated from lateral to medial. A chilled water-based gel facilitates the laser hand-piece movement as well as soothes the skin. The end point is reached when the vessel is no longer seen or a grayish hue is noted over the vessel. Multiple passes with focused energy delivered thru the 2-mm hand piece are not recommended and may lead to injury. Following treatment of individual lesions, a larger-diameter hand piece is used and energy settings are decreased. The laser is passed over the affected area three times in a painting



Figure 7 Rosacea patient D. Frontal view pretreatment.



Figure 8 Rosacea patient D. Frontal view posttreatment.

motion. The diffuse laser treatment is intended to even out erythema and blend in the skin tones. Posttreatment patients appear slightly red and flushed, but purpura formation is uncommon. An ice pack is given to cool the area, and the redness usually resolves within a couple hours. Blister formation and permanent scarring are rare



Figure 9 Rosacea patient D. Left oblique view pretreatment.



Figure 10 Rosacea patient D. Left oblique view posttreatment.

and avoidable with proper patient selection and low-energy laser settings. Most patients feel comfortable returning to regularly scheduled activities that day. Improvement from flushing, pain, and the deep redness of rosacea can be expected within a week. Most patients prefer a series of three treatments to reach stable control of the rosacea. This seems to provide a plateau in symptoms for many months after which time patients may return for maintenance series (Figs. 7–10).

CONCLUSION

The knowledge of using lasers to treat cutaneous lesions continues to advance. The ability to target chromophores specific to a lesion allows clinicians to treat abnormal cells, with as little damage as possible to the surrounding normal cells. Rosacea is a very common condition that adversely affects millions of individuals. Solar lentigines are a cosmetic nuisance resulting from too much sun exposure. Both conditions can be treated safely and efficaciously with the KTP laser. Our results from clinical experience using the laser in the office have been very promising. Patient satisfaction from the procedure is very high and is well tolerated.

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