The Use of Lasers and Intense Pulsed Light for Treating Melasma

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Melasma is a common acquired pigmentary condition. It often affects the face in a symmetrical pattern and, because of its visible nature, can have a significant psychological impact. There are 3 clinical subtypes of melasma: epidermal, which presents as bilateral light brown macules and patches affecting both cheeks and the face; dermal, or Hori's macules, which presents as speckled or confluent brownish-blue or slate gray pigmentation over the face; and mixed-type, which is a combination of both subtypes.

Conventional treatment includes using a combination of topical bleaching agents. Hydroquinone, tretinoin, vitamins C and E, α-hydroxy acid, kojic acid, and azelaic acid are effective but often result in an incomplete response. Lasers and intense pulsed light have recently been used as a novel treatment for this distressing condition.

The results of previous studies have discouraged the use of lasers in treating melasma. More than a decade ago, Grekin et al[1] concluded that the pulsed dye 510-nm laser could not remove melasma and could increase pigmentation. Melasma was later shown to resist treatment with the Q-switched ruby laser (QSRL), regardless of fluence (7.5–15 J/cm^2).[2] There was no permanent improvement; in some cases, hyperpigmentation developed. These findings are consistent with the author's experience. In epidermal and mixed-type melasma, hyperpigmentation may occur following treatment with a pigment laser. The cause for such unwanted effects is unknown but likely related to the pathogenesis of melasma. It has been suggested that in epidermal and mixed-type melasma, characterized by epidermal hyperpigmentation, the pathogenesis involves increased melanocytes and increased activity of melanogenic enzymes overlying solar radiation–induced dermal changes.[3] This recent observation may explain why hyperpigmentation may develop after treatment with a pigment laser. Increased melanogenic enzyme activity suggests that melanocytes are hyperactive. Sublethal laser damage to these melanocytes by a pigment laser may increase melanin production from these melanocytes and result in hyperpigmentation.

The photomechanical effect of the QS laser may also contribute to increased risk of hyperpigmentation.[4] The QS laser generates high-energy radiation with very short pulse duration and produces intense energy leading to rapid temperature rise (1000°C) within the target subcellular chromophore. When the laser pulse duration is shorter than the thermal relaxation time of the target, a temperature gradient is created between the target and its surrounding tissue. When the temperature gradient collapses, localized shock waves are generated that cause fragmentation of the target. This photomechanical reaction leads to the melanosomal disruption that is seen after QS laser irradiation. Studies that examined the use of the QS laser and the long-pulsed 532-nm Nd:YAG laser in the removal of lentigines in patients with dark skin indicated that the long-pulsed 532-nm laser is associated with lower risk of postinflammatory hyperpigmentation (PIH).[5] The long-pulsed laser differs from the QS laser in that it has a photothermal, but not photomechanical, effect. Intense pulsed light (IPL), which emits a broad band of visible light from a noncoherent filtered flashlamp, also produces only photothermal effects. Recent studies of IPL used in removing lentigines in Asian patients have confirmed its effectiveness.[6,7] No cases of PIH were observed in several independent studies. Studies of IPL and of the long-pulsed 532-nm Nd:YAG laser have confirmed that the photomechanical effects of the QS laser are unacceptable and may lead to increased pigmentation.[8,9]

In addition to unwanted photomechanical effects, the wavelengths used may be associated with adverse

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effects. For a 510-nm pulsed dye laser or a 532-nm Nd:YAG laser, the wavelengths are absorbed by hemoglobin as well as melanin. Purpuric macules may occur and correlate with the histological changes of erythrocyte coagulation within the superficial vessels. Damage to the superficial vessels leads to inflammation and consequent PIH.

Sunblock should, whenever possible, contain zinc oxide and titanium dioxide and be applied 1 hour before any outdoor activity and every 3 hours thereafter. Many combinations of tretinoin, hydroquinone, topical steroid, α-hydroxy acid, kojic acid, or azelaic acid have been used as topical bleaching agents.[10,11] In the author's practice, tretinoin 0.05% cream mixed with hydroquinone 4% and fluocinolone acetonide 0.01% is the preferred combination. Despite the application of a topical steroid, this combination may still cause irritation. In such cases, mometasone furoate may offer some relief. Once a patient tolerates topical treatment, other bleaching preparations, including glycolic acid, vitamins C and E, and kojic acid, may be added. In addition, the author performs a mild glycolic acid peel (concentration, 35%; duration, 2–5 minutes) monthly for 2 to 3 months before commencing laser or IPL surgery. Patients are advised to continue sun protection postoperatively. To avoid irritation, topical bleaching agents should be resumed 5 days after laser or IPL surgery rather than immediately following the surgery.

A spot test should be performed on all patients with epidermal or mixed-type melasma. To treat epidermal or mixed-type melasma, the long-pulsed laser (532-nm potassium titanyl phosphate or Nd:YAG) or IPL is preferred. The suggested parameters for IPL in Asian patients are listed in the Table. For the long-pulsed 532-nm Nd:YAG laser, the clinical end point is an ashen gray appearance of the treated skin (suggested parameter, 6.5-J/cm^2 fluence; 2-ms pulse width; 2-mm spot size). To avoid vascular injury and the associated increased risk of hyperpigmentation, the vasculature should be compressed and hemoglobin removed from the vessel. Both actions may be achieved by pushing the IPL handpiece to the skin or, for the laser, by attaching a convex contact window to the handpiece and then pushing the window to the skin (R.R. Anderson, personal communication, December 2001). The QS laser is best avoided or, if necessary, used with the lowest fluence and largest spot size (QS 1064-nm Nd:YAG, 1.4-J/cm^2 fluence; 6-mm spot size). In all patients, topical mometasone furoate should be applied immediately following laser or IPL surgery. Despite these precautions, increased pigmentation occurs in 10% to 15% of patients; such risks should be emphasized before treatment. Mixed-type melasma appears to be associated with greater risk of hyperpigmentation than epidermal melasma and may be associated with functionally abnormal melanocytes that extend to the appendageal rather than just the epidermis.

Resurfacing lasers have also been used with some success in treating melasma. The aim of the ablative laser is to remove only the abnormal melanocytes that are thought to be found along the basal layer of the

Suggested Intense Pulsed Light Parameters for Asian Patients*

| | Wavelength (nm) | Energy (J/cm^2) | |
		Mean	Range
Palomar (Estelux® Pulsed Light System; LuxG™ Pulsed Light Handpiece)	500–670; 870–1400	28	17–30
Ellipse	400	8	8
Aurora	580	25; RF, 20	20–28
Quantum	560	23	19–29
	640	30	24–35
VascuLight™	550–590	36	33–55

*RF indicates radiofrequency.
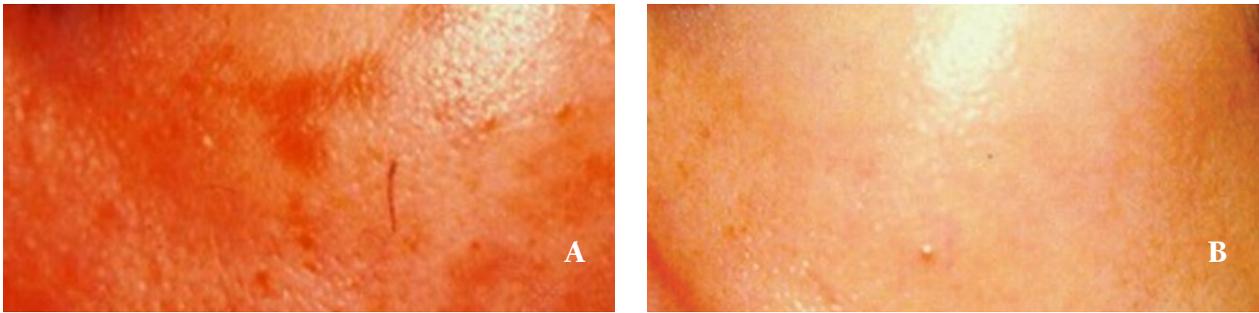
Acquired bilateral nevus of Ota-like macules before laser treatment (A) and after 9 treatments with the Q-switched alexandrite laser (8 J/cm^2)(B).

epidermis. The melanocytes along the appendageal are normal. Manaloto and Alster[12] treated 10 patients with refractory melasma with the Er:YAG laser. Significant improvement was seen 3 to 6 weeks later, but biweekly glycolic acid peels were required. Angsuwarangsee and Polnikorn[13] compared the combined carbon dioxide laser and QS alexandrite laser (QSAL) with the QSAL alone in treating refractory melasma. The combined approach yielded better results but was associated with more adverse effects, including PIH that occurred in 2 out of 6 patients. These findings suggest that functionally abnormal melanocytes are unlikely to be confined to the epidermal basal layer.

Chemical peeling performed immediately after the use of a pigment laser has also been used with some success in a series of patients with a range of pigmentary conditions, including melasma and freckles.[14] As these patients had mixed etiology, it is difficult to assess whether epidermal or mixed-type melasma alone responds well to such combined treatment.

Fractional skin resurfacing is a new development that uses a 1540-nm laser to create microscopic spots of thermal injury that are surrounded by healthy skin tissue.[15] As the area of thermal injury is very small, the lateral migration of keratinocytes occurs rapidly, leading to complete re-epithelialization of the epidermis within 24 hours. Recent studies have indicated that it may be used effectively for treating epidermal melasma, with significant improvement in 60% of patients and mild improvement in 30%.[16,17] Although improvement may certainly occur after such treatment, the recurrence rate is not yet known, and longer-term follow-up is necessary to assess the efficacy of this treatment.

The Use of Lasers for Treating Acquired Bilateral Nevus of Ota-Like Macules

Acquired bilateral nevus of Ota-like macules (ABNOMs), or Hori macules, have frequently been classified as dermal melasma (Figure). The reason is that ABNOMs, like epidermal or mixed-type melasma, present as acquired hyperpigmentation that usually affects the bilateral malar regions. However, as the lesions are a form of dermal melanosis, they appear clinically as bluish rather than brown. Epidermal melasma frequently coexists with ABNOMs. Other areas of the face may also be affected, including the temples, the root of the nose, the alae nasi, the eyelids, and the forehead.[18,19]

The use of the QS laser has generated much interest. Previous work with the QSRL (7- to 10-J/cm^2 fluence, 1-Hz repetition rate, 2- to 4-mm spot size) indicated that complete clearance could be obtained in more than 90% of patients treated.[20] There was no recurrence after 6 months to 4.3 years (mean, 2.5 years) of follow-up. PIH was common, affecting 7% of patients. The QS 1064-nm Nd:YAG laser is also effective, but PIH affects 50% to 73% of patients treated with this laser.[21,22] A more recent retrospective analysis of 32 female Chinese patients treated with the QSAL (755 nm, 8-J/cm^2 fluence, 3-mm spot size) concluded that 80% of patients had greater than 50% clearance and more than 28% had complete clearance (Figure, B).[23] Patients with posttreatment PIH were given topical hydroquinone and tretinoin cream. Patients underwent a mean of 7 treatment sessions (range, 2–11), with a mean treatment interval of 33 days. Results were assessed by 2 independent observers. Hyperpigmentation occurred in 12.5% of the patients but resolved in all cases following treatment with topical bleaching medication.

In a pilot study, carbon dioxide laser followed immediately by the QSAL was effective in treating dermal melasma in 4 patients.[24] More recently, epidermal ablation with the scanned carbon dioxide laser followed immediately by the QSRL has also been shown to be effective and achieved a greater degree of improvement than the QSRL alone. Transient hypopigmentation was the main adverse effect.[25]

Current research suggests that ABNOMs are more resistant to treatment than nevus of Ota; there is a higher rate of postoperative pigment disturbance. Thus, all patients should be prescribed topical bleaching agents both preoperatively and postoperatively. The author's practice is to treat such patients more frequently, with laser procedures repeated every 4 weeks. The intention is to treat the area before epidermal repigmentation occurs. In doing so, more laser energy can reach the dermal target chromophore through a hypopigmented epidermis without the competitive absorption of epidermal melanin. For resistant cases (failure to improve after 4 treatment sessions), QSAL treatment is followed immediately by QS Nd:YAG treatment. The fluence should be lower (4–5 J/cm^2 for both lasers), and the repetition rate should be reduced (to ≤3.3 Hz) to lower the risk of adverse effects. Nevertheless, transitory pigmentary disturbance still occurs, and patients should be warned of this before starting treatment. It has been claimed that IPL may be used for treating dermal pigmentation, including ABNOMs. However, the author's opinion is that this approach can be associated with a high risk of scarring and should not be endorsed.

Conclusion

Lasers and IPL may be used for treating melasma. For epidermal and mixed-type melasma, hyperactivity of the functional melanocytes must be treated first before performing a spot test to assess the clinical efficacy of lasers and IPL. Fractional resurfacing is a new technology that may be used for treating epidermal and mixed-type melasma. A longer-term study is necessary to assess the recurrence rate after improvement with fractional resurfacing. The QS laser should be used to treat ABNOMs, but IPL should be avoided since it is associated with a greater risk of scarring in dermal pigmentation.

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