Observations

Q-Switched Ruby Laser Therapy of Nevus of Ota

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- **Background.**—The Q-switched ruby laser has been demonstrated to provide selective photothermolysis of pigmented tissue at a wavelength of 694 nm and a pulse width of 40 ns with dermal penetration. It was used to treat 15 patients with nevus of Ota involving the face with an age range of 6 to 52 years. Other methods of treatment for the nevus of Ota have either left scarring or were ineffective. The clinical efficacy of this laser treatment was evaluated in a comparative photographic analysis.

**Observations.**—Complete clearing was noted in four of the 15 patients and a minimum of 50% lightening of the original color in the remaining 11. Ten of the 15 patients were Asian, two were white, two were Hispanic, and one was Indian. The energy fluence used varied between 6 and 10 J/cm², and the number of treatments ranged from 1 to 7. Significant lightening or clearing was found at the higher energy ranges of 9 to 10 J/cm² with significantly less lightening noted at the lower energy range of 6 to 8.5 J/cm². No scarring was noted in any of the 15 patients, and some isolated hypopigmentation was noted in one of the subjects. Transient postinflammatory hyperpigmentation of 2 months' duration was noted in only one patient.

**Conclusion.**—Q-switched ruby selective photothermolysis appears to be an effective and safe method of lightening or removing nevus of Ota.

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Nevus of Ota is a nevus consisting of dermal melanocytes, usually involving the first and second branches of the trigeminal nerve. Less commonly, the third branch of the trigeminal nerve may be affected. Approximately half of these lesions are noted at birth, while most appear by the second decade of life. The nevus is most commonly found in females (80% of all reported cases) and its incidence is most common in Asians. An incidence of 0.6% has been noted among the Japanese.1 Nevus of Ota does not usually result in complications, however, malignant degeneration has been reported within the eye on rare occasions.2,3 Treatment of nevus of Ota has been limited primarily to cosmetic camouflage. The argon laser has also been reported to be of benefit in nevus of Ota, however, textural change and permanent loss of pigmentation is often noted with the use of this laser.4,5

The ruby laser was first used on human skin by Goldman et al.6 The addition of the Q-switched mechanism to the standard ruby laser has allowed for the delivery of high peak energy fluences and a shorter pulse width. In the past decade, the use of a Q-switched ruby laser with a pulse duration of 40 ns at 694-nm wavelength of light has been demonstrated to remove many types of tattoos and provide organelle-specific selective damage to melanosomes.7,9 This selective damage has been demonstrated in both animal and human models.10 Selective photothermolysis of melanosomes in human skin can also be performed with a 351-nm excimer laser11 and the Q-switched 1064-nm neodymium-yttrium aluminum garnet laser.12 The depth of penetration of the excimer laser is minimal compared with the Q-switched ruby laser, which is capable of much deeper penetration within the dermis. The Q-switched ruby laser has been demonstrated to penetrate 1 to 2 mm within the dermis. While the Q-switched yttrium aluminum garnet laser is also capable of deep penetration within the dermis, it has not yet been studied in human subjects with pigmented lesions. In an effort to determine the effectiveness of the Q-switched ruby laser on the nevus of Ota, 15 patients were treated with the Q-switched ruby laser and the results were evaluated.

**PATIENTS, MATERIALS, AND METHODS**

Fifteen patients with nevus of Ota presented to the Laser Section of the Skin and Cancer Unit of the New York (NY) University Medical Center. The diagnosis was confirmed by biopsy in each patient. Ten of the 15 patients were Asian, two were white, two were Hispanic, and one was Indian. The treatments were performed after approval of the Institutional Review Board of the New York University Medical Center and the Laser Safety Committee. Informed consent was obtained as part of the investigational study. The age of the patients ranged from 6 to 52 years old.

Patients were either treated with no anesthesia or local anesthesia using 1% lidocaine with epinephrine by direct infiltration of the lesion or regional nerve block. Treatment intervals ranged from 1 to 6 months. In most cases, the entire area was treated in each treatment session; however, in the two children, smaller treatment sessions were required be-

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Fig 1.—Top left, A 33-year-old Asian (patient 11) with a nevus of Ota preoperatively. Top right, Patient 11 following two treatments with the Q-switched ruby laser at 9.9 J/cm², 694 nm, and 40-ns pulse width. Bottom, Patient 11 following four treatments with the Q-switched ruby laser.

Fig 2.—Left, A 25-year-old Asian man (patient 7) with a nevus of Ota on his left cheek. Right, Same patient, following three treatments with the Q-switched ruby laser at 8.5 J/cm², 694 nm, and 40-ns pulse width.
cause of discomfort during the procedure and lack of tolerance on the part of the patients.

The Q-switched ruby laser (Model RD1200, Lasermetrics, Englewood, NJ) was delivered at 694 nm with a pulse width of 40 ns using a 5-mm spot with 10% to 20% overlap. The laser light was delivered through an articulated arm. The energy fluence used ranged from 6 to 10 J/cm². As confirmed with a laser pulse energy meter (Gentec Thermople Power Monitor, Plattsburgh, NY) the energy fluence used was determined by the observation of a “threshold” radiant exposure response that was defined as an immediate whitening of the treated site. The threshold responses were variable, based on the patients’ skin type, with the Asian patients (skin phototypes IV-V) requiring slightly lower energy (7.5 to 8.5 J/cm²) to obtain threshold compared with the white and Hispanic patients (skin phototypes II-IV) (8.5 to 10 J/cm²). During the treatment sessions, eye protection was provided to each patient as well as the clinical staff. Treatment of the eyelids was performed with the application of a topical anesthetic (tetracaine hydrochloride) followed by the application of a gold-plated lead shield over the ocular globe itself. In those patients with scleral involvement of the nevus, no effort was made to treat the sclera itself. The postoperative wounds were dressed with a topical antibacterial ointment (polymyxin-bacitracin) and a nonadherent occlusive dressing (Telfa). Once the threshold response had been obtained, minimal epidermal sloughing with slight crusting took place and complete healing was noted within 4 to 6 days.

Photographs were taken of all patients before and at each return visit (4 to 24 weeks) after each treatment session, including the final treatment session in this study. An attempt was made to take all photographs with the same camera, magnification, lighting, angle, and film exposure. The photographs were then evaluated by three medical photographers, one nurse, and the investigating physician. Pretreatment and posttreatment photographs were projected simultaneously, and response of the entire lesion was determined according to the protocol established by
Garden et al. The percentage of lightening from 0% to 100% was determined in comparison with normal skin with increments of 5% used. One hundred percent represented complete clearing with no detectable difference from normal skin. Each observer’s responses were tabulated individually to ensure that no bias was present.

RESULTS

A minimum of 50% lightening was seen in all patients. Complete clearing was noted in four of the 15 patients (Figs 1 and 2). No hypertrophic or atrophic scarring was noted in any of the patients. Scattered areas of depigmentation were noted in one patient up to 6 months following the last treatment session. There was one instance of postinflammatory hyperpigmentation lasting only 2 months. Of the four patients with complete clearing, two were Asian, one Indian, and one white. The study size was too small to determine whether or not significant differences existed among the different genetic backgrounds and skin types treated. The use of local anesthetics directly into the lesion or by regional nerve block did not adversely affect the clinical results of the laser treatment. The only patients to require local anesthetic of the entire lesion for each procedure were the two children in the study. Four of the patients received local anesthesia over part of the lesion (eyelids) and no difference in terms of the clinical response was noted between the anesthetized and nonanesthetized regions. Postoperative biopsy specimens were taken in areas of clinical clearing in two patients. The biopsy specimens were taken in treated areas adjacent to the preoperative biopsy sites, where the original nevus was confluent and not nottoned in its original appearance. The histopathologic examination revealed residual nevus in the deep reticular dermis with complete absence of nevus cells in the papillary dermis. There was no evidence of fibrosis (Figs 3 through 5).

With each patient, lightening of the nevus was noted after the first session with improvement noted after each and every session. The maximum effect of the treatment was found after the last session. No significant differences in the degree of clearing were noted among those patients with shorter mean treatment intervals compared with those with longer mean treatment intervals. The degree of lightening after each treatment session was variable and not consistent within each patient’s treatment protocol. While 11 of the 15 patients did not achieve complete clearing at the point at which the study was undertaken, these patients have elected to continue treatment beyond the end of the study in an effort to obtain further lightening or clearing of their nevi.

COMMENT

This study demonstrates the effective use of the Q-switched ruby laser in the treatment of dermal pigment of nevus of Ota. This treatment appears to be advantageous compared with others because of the lack of scarring and low incidence of pigmentary loss. Other treatments available at this date have included either a significant risk of textural change or a lack of efficacy in removing the pigment. The safe and efficacious use of this laser technique is further emphasized by the fact that the two children in the study were treated without scarring.

The mechanism of action of this treatment relates to selective photothermolysis. With this concept, organelle-specific selective damage to melanosomes takes place. Following treatment with the Q-switched ruby laser, one sees nuclear injury that is postulated to be caused by thermomechanical destruction as a result of damage to nearby melanosomes. On treatment with the Q-switched ruby laser, there is clinical whitening of the area for approximately 30 to 45 minutes. With the laser application, there are extremely high thermal temperatures generated that create water vapor within the tissue, thus creating the clinical whitening. Hruza et al has demonstrated that Q-switched ruby laser treatment of pigmented cells results in melano-
some rupture and the sparing of poorly melanized stage I and II melanomas. They postulated that absorption by melanin is necessary for damage to occur to the melanosome.

The energy fluences used in this study are higher than those reported in other studies for the removal of tattoos (2 to 6 J/cm²). Although the exact reason for this difference is not clear, it is possible that patients with nevus of Ota may have a darker skin prototype that would require a higher energy fluence to obtain the desired threshold response. It should also be noted that the new commercial Q-switched ruby lasers use a shorter pulse width (20 to 28 ns) than the 40 ns in the research prototype in this study. The shorter pulse width will allow for a higher energy fluences, thus making the energy fluence required to obtain the threshold response less than that required in this article.

Dermal tissue in the nevus of Ota is heavily laden with melanin, which provides an excellent target for the Q-switched ruby laser. Postoperative biopsy specimens following healing of the Q-switched ruby laser treatment of the nevus of Ota revealed a completely normal papillary dermis with some deep dermal nevus cells remaining. The absence of fibrosis in the postoperative biopsy specimens is consistent with the total absence of clinical scarring in these patients.

The persistence of deep dermal melanocytes following treatment does not result in the clinical persistence of the nevus of Ota. It is unclear, however, whether or not recurrence of the original color will return over time as a consequence of the deep dermal nevoid cells. However, it should be noted that a 12- to 18-month follow-up in three of the patients following their last treatment session did not reveal any evidence that they had returned of the original pigment.

Significant lightening noted among children raises the possibility that patients born with this extensive facial nevus need not face the embarrassment or consequences associated with a facial birthmark of this type. The fact that the Q-switched ruby laser has effectively eliminated most of the dermal pigment in these patients raises the possibility of the use of this laser technique in the treatment of other melanocytic processes with dermal involvement, including nevus of Ito, Becker’s nevi, nevus spilus, blue nevi, and congenital nevi. To determine what the broader role of the Q-switched ruby laser will be in the treatment of other pigmented lesions, further analysis and postoperative observation will be required.

References
