# Q-Switched Ruby Laser in the Treatment of Nevus of Ota

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***Background*: The Q-switched ruby laser has recently shown that it can remove tattoos without scarring. Therefore the Q-switched ruby laser is expected to be effective in the treatment of nevus of Ota, which contains pigmented cells in the dermis.**

***Objective*: The purpose of this study is to evaluate the efficacy of Q-switched ruby laser in the treatment of nevus of Ota.**

***Methods*: Twenty-five patients (6 men, 19 women) with nevus of Ota on the face were treated. The age of the patients ranged from 3 to 62 years. The energy fluence used varied from 6 to 8.5 J/cm$^2$. Treatment intervals ranged from 1 to 3 months, and the number of treatments ranged from 2 to 9.**

**Photographs were taken of all patients before and on every return visit. The photographs were then compared with each other. After completion of treatment, we evaluated some parameters including the extent of pigment-free area within the skin lesions (score 0-4), degree of lightening in the remaining skin lesions (score 0-3), and patient's own or their parents' opinions on the result of treatment (score 0-3). The scores of the above three parameters were added and the resulting scores were designated as excellent (score 9-10), good (score 7-8), moderate (score 5-6) and poor (score 0-4).**

***Results*: Excellent treatment response (score 9-10) was obtained in 6 of the 25 patients. In all patients disappearance of pigmentation on a 40 percent or larger area was seen. One month after completion of treatment, the remaining lesion size was less than 40 percent of the original lesion in 21 (84.0%) patients. The degree of lightening in the remaining lesion was marked (score 3) in 22 (88%) patients. No scarring was noted following treatment. Transient hyperpigmentation was noted in 7 patients, and transient hypopigmented areas were noted in one patient.**

***Conclusion*: Q-switched ruby laser appears to be an effective and safe modality for the treatment of nevus of Ota. (Ann Dermatol 8:(1) 6~13, 1996).**

*Key Words* : Q-switched ruby laser, Nevus of Ota

The physiologic significance of nevus of Ota to the host may be none, but the effect on one's psychologic and social life is enormous. Therefore, an effective and side effect-free treatment for nevus of Ota has always been sought. The effect of laser beam on melanin and melanosomes has been the subject of study since the early 1960s when Goldman demonstrated the effect of the normal-mode (500-ms pulse duration) ruby laser on the human epidermis[1]. In subsequent studies using the Q-switched ruby laser with a shorter pulse duration (50 ns), the exposure threshold of damage was found to be

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**Table 1.** Ruby laset treatment of nevus of ota

| Pts | Age(yrs) | Sex | Type* | Age of onset | MEF(J/cm$^2$) | MTI(months) | No. Of TSA | TR |
|---|---|---|---|---|---|---|---|---|
| 1 | 33 | F | Ib | 0 | 7 | 2 | 3 | G |
| 2 | 6 | M | Ia | 0 | 6 | 2 | 3 | G |
| 3 | 16 | F | Ia | 1 | 8 | 1 | 5 | G |
| 4 | 17 | F | Ib | 10 | 8 | 1 | 4 | G |
| 5 | 23 | F | III | 5 | 7.5 | 1 | 9 | E |
| 6 | 21 | F | II | 13 | 8 | 1.5 | 6 | G |
| 7 | 16 | M | II | 0 | 8 | 1 | 6 | E |
| 8 | 33 | F | III | 0 | 8 | 2.5 | 6 | E |
| 9 | 32 | F | Ia | 15 | 7 | 2 | 4 | F |
| 10 | 3 | F | IV | 0 | 6 | 3 | 2 | G |
| 11 | 14 | F | Ib | 2 | 7 | 1 | 3 | G |
| 12 | 18 | F | Ia | 0 | 6 | 2 | 5 | E |
| 13 | 22 | M | III | 0 | 7.5 | 2 | 3 | F |
| 14 | 53 | F | III | 15 | 7.5 | 2 | 5 | E |
| 15 | 62 | F | III | 7 | 8 | 2 | 4 | G |
| 16 | 19 | M | III | 0 | 8 | 1 | 4 | G |
| 17 | 25 | F | II | 0 | 8 | 1 | 6 | G |
| 18 | 18 | F | III | 0 | 7 | 3 | 3 | F |
| 19 | 37 | F | IV | 27 | 7 | 1 | 5 | E |
| 20 | 44 | F | II | 19 | 8.5 | 1.5 | 4 | F |
| 21 | 24 | F | II | 22 | 8 | 1 | 3 | F |
| 22 | 13 | F | III | 0 | 8 | 2 | 3 | G |
| 23 | 45 | M | III | 0 | 8 | 1 | 4 | G |
| 24 | 34 | M | II | 13 | 8 | 1 | 5 | G |
| 25 | 22 | F | III | 0 | 8 | 1 | 3 | G |

*, Tanino's classification; o, at birth; MEF, mean energy fluence; MTI, mean treatment interval; TSA, treatment over surface area; TR, treatment response; E, excellent; G, good; F, fair

independent of skin type. The damage by shorter pulse duration is 10 to 100 times less than that by longer pulse duration. The former exerts a more selective effect, perhaps at the level of melanosome. This damage has been demonstrated in both animal and human models[2,3]. Based on the theory of selective photothermolysis, the Q-switched ruby laser with a pulse duration of 40 ns at 694-nm wavelength has been used and demonstrated to remove several types of tattoos efficiently[2,3].

Nevus of Ota is a benign mesodermal melanocytosis over the regions innervated by the first (ophthalmic) and second (maxillary) branches of the trigeminal nerve[4]. In early days treatment of nevus of Ota had been limited primarily to cosmetic camouflage[4]. Later the cryotherapy and argon laser have been reported to be of benefit in the treatment of nevus of Ota, however, ensuing textural change, hyperpigmentation and permanent loss of pigment are often noted with these modalities[5]. In an effort to evaluate the effectiveness of the Q-switched ruby laser on the nevus of Ota, twenty-five patients were treated with it and the results were evaluated.

## PATIENTS AND METHODS

Twenty-five patients (6 men, 19 women) with nevus of Ota visited our Dermatologic Clinic. Clinical diagnosis of nevus of Ota was made and biopsies were performed before and after treatment on three patients. The age of the patients ranged from 3 to 62 years (Table 1).

No systemic nor local anesthesia were used, except in those two youngest patients who could not tolerate accompanying pain. They were given ketamine (Ketalar®) intravenously (2mg/kg). Treatment intervals ranged from 1 to 3 months. In all cases, the entire area was treated in one sitting ex-

**Table 2.** Criteria of Treatment Efficacy ( Treatment of Nevus of Ota with Q-Switched Ruby Laser )

| I. Extent of pigment-free area within the original skin lesion | | |
|---|---|---|
| | Score No. | of patients (%) |
| < 20 % | 0 | 0 |
| 21 - 40 % | 1 | 0 |
| 41 - 60 % | 2 | 4 (16.0) |
| 61 - 80 % | 3 | 14 (56.0) |
| 81 - 100 % | 4 | 7 (28.0) |

| II. Lightening of color in remaining lesion compared to original skin lesion | | |
|---|---|---|
| | Score No. | of patients (%) |
| no change | 0 | 0 |
| minimal | 1 | 0 |
| moderate | 2 | 3 (12.0) |
| marked | 3 | 22 (88.0) |

| III. Patients' own or their parents' opinion on the result of treatment | | |
|---|---|---|
| | Score No. | of patients (%) |
| poor | 0 | 0 |
| fair | 1 | 3 (12.0) |
| good | 2 | 13 (52.0) |
| excellent | 3 | 9 (36.0) |
| Total | 10 | 25 |

cept in one, the youngest child, in whom it was treated in 2 sittings (Patient 10, Table 1).

The Q-switched ruby laser (Model QSR2 Derma-lase®) was delivered at 694 nm with a pulse duration of 40 ns using 4, 5 and 6 mm spot sizes with 10% to 20% overlap. All patients had test sites treated with 5 or 6 mm spot size with energy fluence ranging from 4 to 6 J/cm$^2$. All tested sites were evaluated at 4 to 6 weeks which then determined the initial energy fluence. We controlled the energy fluence so that immediate whitening lasted for about 3 minutes at the site of the laser beam irradiation. The energy fluence used ranged from 6 to 8.5 J/cm$^2$ (Table 1).

During a treatment session, eye protection was provided with the use of a gold-plated lead shield over the ocular globe. The postoperative wound was dressed with topical antibiotic ointment (oxymycin®). When a blister formation was found on the treated area the next day, the fluid was aspirated and topical antibiotic ointment was applied. Minimal epidermal sloughing with slight crusting took place and complete healing was noted within 4 to 6 days.

**Table 3.** Tanino's classification of nevus of Ota[23]

| | |
|---|---|
| Ia | mild orbital - upper, lower eyelids |
| Ib | mild zygomatic - zygomatic region |
| II | moderate - eyelids, zygomatic region, base of the nose |
| III | intensive - eyelids, zygomatic region, base of the nose and ala nasi, forehead, ear, anterior scalp |
| IV | bilateral |

Photographs were taken of all patients before and at each and every return visit up to 12 months. An attempt was made to take all photographs using the same camera, at the same distance, angle, with the same magnification, lighting, and exposure time. The photographs were then compared with one another. Clinical improvement was scored independently by three physicians. The extent of pigment-free area within the original skin lesions was scored from 0 to 4 at 20% intervals (Table 2-I). One hundred percent

Fig. 1. Nevus of Ota before treatment with Q-switched ruby laser (patient 14).

Fig. 2. Excellent result was obtained with this patient after five treatment sessions with Q-switched ruby laser. Some remaining lesion was noted on the medial side of the eyelids in which lightening of color was marked (patient 14).

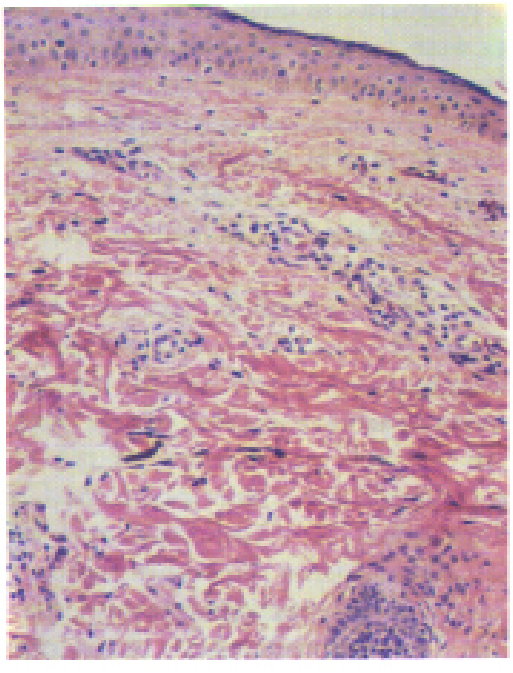

Fig. 3a. Biopsy specimen before treatment revealed dendritic melanocytes in the mid-dermis (H&E, × 100, patient 23).

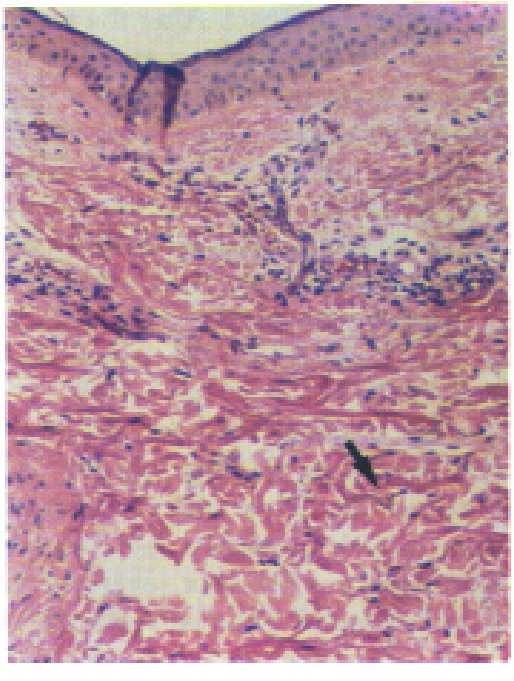

Fig. 3b. The biopsy specimen following treatment showed few melanocytes(arrow) in mid-dermis. However, clinically nevus of Ota disappeared on this site (H&E, ×100, patient 23).

represents complete clearing of a lesion. The degree of lightening in the remaining skin lesions compared to original skin lesions was scored from 0 to 3 (0, no change; 1, minimal; 2, moderate; 3, marked or complete clearing) (Table 2-II). At the last visit (1 to 12 months after completion of treatment) we obtained the patients' own or their parents' opinions on the result of the treatment, and scored it from 0 to 3 (0, poor; 1, fair; 2, good; 3, excellent) (Table 2-III). The scores of the above three parameters were added and designated as excellent (score 9-10), good (score 7-8), fair (score 5-6) and poor (score 4-0) (Table 1).

In three patients, a biopsy was taken from the lesions prior to the treatment (Fig. 3a). A postoperative biopsy specimen was taken in an area of clinical clearing adjacent to the pretreatment biopsy site (Fig. 3b).

## RESULTS

Excellent results (score 9-10) were noted in 6 (24.0%) of the 25 patients (Table 1, Fig. 1 & 2). In all patients, disappearance of lesion on a 40 percent or larger area was seen (Table 2-I). One month after the last treatment the lightening of color of nevus was marked (score 3, Table 2-II) in 22 (88%) patients. The degree of lightening after each treatment session was variable and not related to the patient's treatment protocol. After the first session the lesion did not seem to show much change, in color or in size. In many patients the degree of lightening was most marked following the third or fourth treatment and less so following subsequent treatments. In the youngest patient (Patient 10), aged 3, although she was treated only twice the effect of laser treatment was most striking (Table 1). One patient was observed up to 12 months after the last laser treatment. The lesion had not changed clinically.

After the first treatment transient blister formation was seen in 9 patients, in one of whom blisters appeared again after the second treatment. These blisters dried up with no sequelae. On the eyelids, no blister formation was seen but severe edema was frequently observed. A pinprick sensation accompanied whitening, erythema and edema. It was more severe with the first treatment and diminished in severity on subsequent treatments. As the number of treatment session increased, the immediate whitening became less marked or was even not forthcoming, and then, the exposure dose had to be increased with less marked whitening

In seven (28.0%) patients following the treatment, transient hyperpigmentation was noted, which lasted 2 to 6 months after treatment. In one patient scattered transient hypopigmented areas were seen up to 9 months after the last treatment. No scarring developed in any patient.

In three patients, a biopsy was taken from the lesions prior to the treatment (Fig. 3a). A postoperative biopsy specimen was taken in an area of clinical clearing adjacent to the pretreatment biopsy site. The histology revealed few melanocytes in the mid-dermis. However, clinically nevus of Ota disappeared on this site (Fig. 3b).

One to 12 months after completion of treatment, 22 (88%) patients felt that the results of treatment were good (score 2) or excellent (score 3) (Table 2-III).

## DISCUSSION

Nevus fuscocaeruleus ophthalmomaxillaris was first described by Ota in 1939[6]. Ota and Tanino later presented several cases which they termed "nevus fuscocaeruleus ophthalmo-maxillaris"[7]. Subsequently, several large series of cases were reported, notably, by Yoshida[8], 110 cases, and Hidano[9], 240 patients. In these series, about 80% of the patients were females. In over half the cases the lesions were first noted at or soon after birth, others during the teens, possibly due to hormonal influence. Onset after 21 years of age is rare. The lesions persist throughout life. The nevus of Ota most often affects Asians. An incidence of 1 in 500 has been reported in Japan[9].

Recently, various modalities have been used in the management of nevus of Ota. Camouflage cosmetics are time consuming, messy and frustrating for patients trying to achieve a perfect match. Surgical excision is not indicated because of the typically large size of lesion and cosmetic concern. Chemical bleaching agents or cryotherapy may be used. However, these agents sometimes induce permanent damage to epidermal melanocytes leading to irreversible hypopigmentation or depigmentation[10,11]. Sequential dry ice application combined with argon laser exposure has been reported as an effective treatment for the nevus of Ota. But the

continuous wave radiation of the argon laser causes nonspecific thermal injury[12].

This study demonstrates the effectiveness of the Q-switched ruby laser in the treatment of nevus of Ota. This laser typically produces pulses of 30 to 50 nanoseconds, which are less than the 50 to 100 nanoseconds, depending on their size, thermal relaxation time of melanosomes[10,13]. The long wavelength of the Q-switched ruby laser (694 nm) is necessary to induce selective damage to melanosomes within melanocytes that lie deep in the nevus of Ota[14].

The mechanism of action of Q-switched ruby laser treatment relates to selective photo-thermolysis[15]. The premise is that with this modality organelle-specific selective damage to melanosomes takes place. Following this treatment, one sees nuclear injury that is postulated to be caused by thermomechanical destruction as a result of damage to the nearby melanosomes. Hruza et al[3] has demonstrated that Q-switched ruby laser induces rupture of melanosomes but spares the less well melanized stage I and II melanosomes. They postulated that absorption by melanin is necessary for damage to occur to the melanosome.

Dermal tissue in the nevus of Ota is heavily laden with melanin, which provides an excellent target for the Q-switched ruby laser[5]. Selective photothermolysis of melanosomes in human skin can also be induced with a 351-nm excimer laser[14] and the Q-switched 1064-nm neodymium-yttrium aluminum garnet laser[17]. The depth of penetration of the excimer laser is minimal compared to the Q-switched ruby laser[5]. The Q-switched ruby laser has been demonstrated to penetrate 1 to 2 mm into the dermis[2,5], while the Q-switched yttrium aluminum garnet laser is also capable of deep and even deeper penetration into the dermis ranging from 4 to 6 mm[18].

Lowe NJ et al[13] repoted that after 4 treatments all 16 patients treated with Q-switched ruby laser showed a 50 percent or greater improvement. In a recently repoted study in the nevus of Ota which was treated with a Q-switched Nd:YAG laser excellent or good response was noted in 68% of patients[19]. In our study the number of treatment sessions ranged from 2 to 9 with an average of 4.3. In the youngest child (patient 10), aged 3, who was given two treatment sessions the response to treatment was good. However, no futher treatment could be given.

On exposure to the laser beam, a pinprick sensation was followed by immediate whitening, erythema and edema. Immediate whitening disappeared in 20 to 30 minutes, and the pinprick sensation in 2 hours. Edema could not be detected on the next day.

Exposure to the laser beam produced immediate whitening which precisely corresponds with the laser spot. Dover et al[2] stated that small vapor cavities induced in the melanosomes by steam and pyrolytic products strongly scatter visible light, causing whitening. Their gradual dissolution would explain the transient nature of the whitening. As the color of the lesion fades through treatment, the degree of immediate whitening becomes less apparent and shorter in duration following subsequent treatments. This is also true even when the fluence of the laser beam is increased. A decreased degree of immediate whitening suggests that large amounts of pigment cells present at the depth of the laser beam penetration have been destroyed in the treated areas as described by Dover et al[2] and Hruza et al[3]. On the following day after the first treatment, blister formation was seen in 9 patients, in one of whom a blister was seen again after the second treatment. Blister formation is thought to be associated with a separation of the dermoepidermal junction[3]. The blister fluid was aspirated and topical antibiotic ointment(Oxymycin®) was applied. The blister dried up with no sequelae. In the eyelids post-treatment edema was more severe but no blister formation was seen.

One month after the completion of treatment, some remaining lesions were found on the eyelids and temples in many patients. Hirayama T. and Suzuki T.[20] classified nevus of Ota histologically into superficial(S), superficial dominant(SD), diffuse(Di), deep dominant(DD) and deep(De) types. The bluish lesions, which are found in Di, DD, and De types failed to disappear completely at the completion of treatment.

In the animal models Dover et al[2] described persistent leukotrichia resulting from follicular damage following irradiation by the Q-switched ruby laser. However, in our patients only transient leukotrichia was found following treatment.

In another study of ours, we found that the treatment of tattoos in the eyebrow region was

followed immediately by a hair color change from black to white and shedding of hair in a few days. Normal colored hair grew again in 3 to 4 months.

Geronemus stated that posttreatment biopsy specimens following a Q-switched ruby laser treatment of nevus of Ota revealed a residual nevus in the deep reticular dermis with a complete absence of nevus cells in the papillary dermis and some nevus cells remaining in the deep dermis[5]. In our biopsy specimens we found similar results. However, despite the persistence of some melanosomes in the mid-dermis following treatment, clinical signs of nevus of Ota disappeared.

This Q-switched ruby laser treatment appears to be advantageous compared to other modalities because of the lack of scarring and the low incidence of depigmentation[21,22]. Other forms of treatments available at this date carries significant risk of textural change or lack efficacy in removing the pigment[5]. Although there were posttreatment hyperpigmentation in seven cases, almost all of them disappeared in 2 to 6 months after the last treatment. It seemed that no relation exists between the incidence of posttreatment hyperpigmentation and energy fluence. The mechanism for this posttreatment hyperpigmentation is unknown, but presumably begins with sublethal alteration of melanosome within the epidermal melanocytes and/or keratinocytes. It is possible that melanosome alteration by selective photothermolysis interferes with the feedback inhibition of melanogenesis, directly stimulates tyrosinase activity, or releases melanocyte-stimulatory factors intracellularly or extracellularly[3]. One patient developed isolated areas of hypopigmentation following treatment area but repigmentation was noted at 9 months after the last treatment. It should be noted that the Q-switched ruby laser appears to destroy completely the abnormal melanocytes in the epidermis of the nevus of Ota but only partially damages the normal melanocytes. For this reason, the nevus does not recur and transient hypopigmentation is reversed[10].

Since the treated area did not change clinically after 3 months, it is suggested that the effectiveness of treatment should be judged at 1 to 3 months after completion of treatment. It is suggested that patients born with this facial nevus and their parents need not be too concerned as the Q-switched ruby laser is a very safe and effective treatment for their condition.

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