Title
Q-Switched Ruby Laser Treatment of a Congenital Melanocytic Nevus

Journal
Dermatologic Surgery, 25(4)

ISSN
1076-0512

Authors
Nelson, J Stuart
Kelly, Kristen M

Publication Date
1999-04-01

DOI
10.1046/j.1524-4725.1999.08270.x

Q-Switched Ruby Laser Treatment of a Congenital Melanocytic Nevus

J. Stuart Nelson, MD, PhD, and Kristen M. Kelly, MD

Beckman Laser Institute and Medical Clinic, Departments of Surgery and Dermatology, University of California, Irvine, Irvine, California

BACKGROUND. The treatment of medium-sized (1.5–20 cm diameter) congenital melanocytic nevi (CMN) has been the concern of dermatologists for decades. Although many techniques have been described and utilized, no single treatment has emerged as applicable under all circumstances.

METHODS. The Q-switched ruby laser (QSRL) at 694 nm, a wavelength well absorbed by melanin relative to other optically absorbing structures in skin, causes highly selective destruction of pigment-laden cells. In addition, the 20-nanosecond pulse duration produced by this laser approximates the thermal relaxation time for melanosomes, thereby confining the energy to the targeted cells.

RESULTS. In the present report, treatment using the QSRL resulted in complete clinical removal of a biopsy-documented medium-sized compound CMN with no recurrence after 5 years. In contrast to other therapeutic modalities, complications such has hypertrophic scarring, dyspigmentation, or atrophy were not observed.

CONGENITAL MELANOCYTIC NEVI (CMN) are present in approximately 1% of newborn infants.[1] Most CMN have a distinctive clinical appearance and usually present as flat, pale tan macules or papules or as well-circumscribed lesions with mottled freckling. With time, CMN may become elevated, and coarse dark brown hairs may or may not become prominent. The classification of CMN is based on the lesion size (diameter) and categorized as small (< 1.5 cm), medium (1.5–20 cm) or large (>20 cm). On histopathologic examination, CMN may appear as an intradermal or compound nevus. Frequently, CMN are characterized by nevus cells between the collagen bundles in the lower two-thirds of the dermis.

A variety of treatment options have previously been utilized to treat CMN, including dermabrasion,[2] serial excisions, or excision with cosmetic repair involving grafts or tissue expanders. The cosmetic results from these procedures may be less than desirable, especially for facial lesions where hypertrophic scarring, dyspigmentation, or atrophy remain worrisome complications. Furthermore, although there is no consensus regarding the risk of developing malignant melanoma, the clinical management of medium-sized CMN is also controversial because of unresolved questions concerning the potential for malignant degeneration.

Even though individual circumstances must be taken into account, medium-sized CMN that are light-colored and benign in appearance may be observed. However, observation over time may not be an appropriate approach, especially when CMN are located on highly visible areas, such as the face where they pose significant cosmetic morbidity and may affect the psychosocial development of the child.

The Q-switched ruby laser (QSRL) utilizes 694 nm wavelength red light, which is well absorbed by melanin relative to other optically absorbing structures in human skin and causes highly selective destruction of pigment-laden cells. In addition, the 20-nanosecond pulse duration produced by this laser approximates the thermal relaxation time for melanosomes, thereby confining the energy to the targeted cells. The QSRL has been used successfully and safely for the treatment of a variety of pigmented lesions including lentigines and nevi of Ota.[3–5] The application of this modality to the clinical management of patients with CMN is controversial as it is not known what effect laser treatment will have on the known malignant potential of these lesions. To date, no adverse effects in this regard have been confirmed. Despite the controversy, the QSRL has been utilized for the treatment of small and medium congenital nevi with sometimes good results.[6–7] However, in these previous reports the CMN were either incompletely removed or recurred within 1 year of laser treatment. The present article describes the complete clinical removal of a biopsy-documented medium-sized compound CMN, using the QSRL with no recurrence after 5 years, which we believe is the first report of such a favorable clinical result.

Patient Case Report

The patient was a 2-month-old Hispanic female referred for consultation to the Beckman Laser Institute and Medical Clinic (BLIMC), University of California, Irvine. The patient had previously been evaluated in the Departments of Dermatology and Plastic Surgery at Loma Linda University Medical Center, Loma Linda, CA, where biopsy of the lesion documented a compound congenital melanocytic nevus. Placement of tissue expanders with serial partial excision was recommended. Evaluation at BLIMC (Figure 1) revealed an approximately 10-cm-diameter flat, well-circumscribed dark brown CMN involving the right lower eyelid, cheek, and upper lip. No hair growth was noted. The lesion was asymptomatic, and the infant was otherwise healthy. There is no family history of malignant melanoma or dysplastic nevus syndrome. In the QSRL (Lasermetrics, Winterhave, FL), high intensity flashlamps were used to excite the ruby crystal (aluminum trioxide doped with chromium ions) to produce red photons at a wavelength of 694 nm with 20 ns pulse durations and extremely high peak powers ($>10^6$ W/cm^2), with 10 J/cm^2 as a maximum energy density.[8] Laser energy was transmitted through an articulating arm, which terminated in a microlens that focused the radiation on a 4-mm circular spot of uniform light intensity. A 2-cm stylus present on the handpiece kept the beam at a constant distance from the target. Proper aiming was facilitated by incorporation of a helium-neon laser aligned coaxially with the QSRL laser. The infant and all attending personnel wore safety glasses that absorbed specifically at the wavelength being used, to prevent inadvertent eye damage during laser use.

After the nature of the procedure had been fully explained to the infant's parents, informed consent was sought and documented on a standard University of California form prior to laser treatment. Inasmuch as the optical characteristics of human skin are important individual variables that must be considered from patient to patient, a 1-centimeter diameter test site was identified on the lateral right cheek on a site representative of the entire lesion using an energy density of 10 J/cm^2. The test site was irradiated with sequential laser pulses overlapped by 25–33% of the beam diameter without the use of local anesthesia. Immediately after laser exposure, an elevated, white-ash colored, desquamating crust was seen on the test site, which resolved within 4–6 hours. Wound care consisted of topical bacitracin antibiotic ointment applied twice a day.

Figure 1. Two-month old Hispanic female with a large compound congenital melanocytic nevus involving the right lower eyelid, cheek, and upper lip, prior to QSRL therapy.

The test site was evaluated at 3 months when complete fading, without scarring or changes in normal pigmentation, was noted. The entire remaining lesion on the right lower eyelid, cheek and upper lip was then treated with the QSRL using an energy density of 10 J/cm^2 during a 15 minute treatment session under general anesthesia on an outpatient basis. The parents were instructed to keep the area trauma free and apply the topical antibiotic ointment should any scaling or crusted areas develop. In addition, the parents were cautioned to avoid excessive sun exposure to the infant's face and to use adequate sunscreen protection. The infant was re-evaluated at 3 months after QSRL treatment at which time complete fading of the entire lesion with the exception of an approximately 2-cm diameter area in the center of the right cheek. The residual lesion was re-treated with the QSRL, using an energy density of 10 J/cm^2 during a 5-minute treatment session under general anesthesia. The infant was re-evaluated at 6 months after the second QSRL treatment at which time complete fading of the entire lesion, without scarring, was noted. More recently, the child was re-evaluated 5 years after QSRL treatment (Figure 2), and no recurrence of the lesion was noted at any previous site. Moreover, no hypertrophic scarring, dyspigmentation, or atrophy was noted.

Figure 2. The same child 5 years after QSRL treatment; there was no recurrence of the lesion at any previous site.

Discussion

The ability of the QSRL to provide effective treatment of benign pigmented lesions without complications such as hypertrophic scarring, dyspigmentation, atrophy, or induration, is well established[3–5] and based upon two factors unique to the laser system: pulse duration and wavelength. The nanosecond pulse duration of the QSRL approximates the thermal relaxation time for melanosomes, thereby confining the energy to the targeted melanin-laden cells. There is minimal diffusion of heat, thereby reducing thermal damage to the adjacent structures.[9] The specificity of the laser in removing the pigment without affecting the surrounding tissue is also related directly to the laser wavelength and the optical properties of human skin.[10] The QSRL produces red light at a wavelength of 694 nm where absorption by hemoglobin is absent; therefore, all photon energy is directed toward the targeted melanin-laden cells, permitting their selective removal.

Previous studies[6,7] have obtained significant improvements in CMN, but to our knowledge complete, long-term, clinical resolution has never been achieved. Complete fading of the entire lesion, without recurrence at any previous site after 5 years, may be related to the early therapeutic intervention when the patient was still an infant. However, the study by Waldorf et al[6] included at least one patient whose treatment began at an age of less than 1 month, but complete resolution was not achieved. In the patient under study, it is likely that the melanocytes, while present in the dermis, were

relatively superficial compared to other CMN where melanocytes may infiltrate deep into the dermis or even subcutaneous structures.

QSRL treatment of CMN is not without controversy. While the relative risk of developing melanoma remains uncertain, medium-sized CMN clearly have malignant potential. The effect of the QSRL on melanocytes with the potential for malignant transformation remains incompletely understood. Rosenbach et al[11] noted that it is reassuring that there have been no reports of malignant transformation in the many benign nevi, including nevi of Ota, previously treated using the QSRL. Waldorf et al[6] have suggested that reducing the number of potentially premalignant cells using the QSRL might even decrease the risk of melanoma, but this hypothesis remains unproven.

In conclusion, QSRL treatment of CMN should be approached with caution and the risks clearly explained to the patient and/or family members. Furthermore, patients should undergo regular and extended follow-up, even when CMN appear clinically resolved. However, QSRL treatment may offer excellent cosmetic results and thus should be considered, especially when CMN are located on highly visible areas such as the face where they pose significant cosmetic morbidity and may affect the psychosocial development of the child.

References

1. Hurwitz S. Clinical Pediatric Dermatology. Philadelphia: W.B. Saunders Company, 1993.

2. Rompel R, Moster M, Petres J. Dermabrasion of congenital nevocellular nevi: experience in 215 patients. Dermatol 1997;194:261–7.

3. Goldberg D. Benign pigmented lesions of the skin: treatment with the Q-switched ruby laser. J Dermatol Surg Oncol 1993;19:376–9.

4. Geronemus RG. Q-switched ruby laser therapy of nevus of Ota. Arch Dermatol 1992;128:1618–22.

5. Cheng CJ, Nelson JS, Achauer BA. Q-switched ruby laser treatment of oculodermal melanosis (Nevus of Ota). Plast Reconst Surg 1996;98:784–90.

6. Waldorf HA, Kauvar ANB, Geronemus RG. Treatment of small and medium congenital nevi with the Q-switched ruby laser. Arch Dermatol 1996;132:301–4.

7. Goldberg DJ. Q-switched ruby laser treatment of congenital nevi. Arch Dermatol 1995;131:621–3.

8. Nelson JS. Laser systems used in plastic surgery and dermatology. In: Achauer BM, Vander Kam V, eds., Lasers in Plastic Surgery and Dermatology. New York: Thieme Med. Pub., Inc., 1992:11–20.

9. Anderson RR, Parrish JA. Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. Science 1983;220:524–7.

10. Anderson RR, Parrish JA. The optics of human skin. J Invest Derm 1981;77:13–9.

11. Rosenbach A, Williams CM, Alster TS. Comparison of the Q-switched Alexandrite and Q-switched Nd:YAG lasers in the treatment of benign melanocytic nevi. Dermatol Surg 1997;23:239–45.

This project was supported by a research grant awarded from the Institute of Arthritis and Musculoskeletal and Skin Diseases (1R01-AR43419) at the National Institutes of Health to JSN. Institutional support from the Office of Naval Research, Department of Energy, National Institutes of Health, and the Beckman Laser Institute and Medical Clinic Endowment is also gratefully acknowledged.
Address correspondence and reprint requests to: J. Stuart Nelson, MD, PhD, Beckman Laser Institute and Medical Clinic, 1002 Health Sciences Road East, Irvine, CA 92612