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BRIEF REPORT

Combination laser therapy as a non-surgical method for treating congenital melanocytic nevi from cosmetically sensitive locations on the body

Emi Funayama[1] · Yuhei Yamamoto[1] · Akihiko Oyama[2] · Naoki Murao[1] · Toshihiko Hayashi[1] · Taku Maeda[1] · Hiroshi Furukawa[3] · Masayuki Osawa[1]

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Introduction

Where possible, the treatment of choice for medium-sized congenital melanocytic nevi (CMNs) is full-thickness surgical excision. However, for CMNs located on anatomical landmarks (e.g., nipple/areola, eyebrow, auricle, lip, eyelid, and nose), excision can yield esthetically and functionally undesirable results. Thus, treatment of medium-sized CMNs can be challenging. Treatment options for CMNs have been reviewed extensively, and the evolution of laser technology has made lasers a viable treatment option. We previously reported the efficacy of a pulsed dye laser (PDL), which was originally used for vascular malformations, in combination with a Q-switched ruby laser (QsRL) in reducing the number of nevus cells in giant CMNs [1]. PDLs are also highly absorbed by melanin, and the pulse duration is much longer than that of Q-switched pigment-specific lasers. PDLs may have strong photothermolytic effects on surrounding nevus cells not containing melanin. These features suggested the potential of the novel use of PDLs in CMNs. In the present study, we refined this technique by adding CO_2 laser treatment for some medium-sized CMNs in cosmetically sensitive locations.

Patients and methods

Between 2008 and 2015, 19 patients with medium-sized CMNs in cosmetically and functionally sensitive locations on the body were treated at the Hokkaido University Hospital using a PDL and QsRL. The median age at first treatment was 9 months (range 1 month to 6 years). The locations of the lesions varied among the patients (head and neck, $n = 14$; trunk, $n = 2$; limb, $n = 3$). Each treatment consisted of a single pass of the PDL followed by a single pass of the QsRL. All patients underwent combination laser treatment every 3–6 months until maximum clearance under general or local anesthesia. Multiple rounds of treatment were applied to all patients. An SPTL-1b PDL (Syneron Candela Corp., Wayland, MA, USA) was used from 2008 to 2012; it was subsequently replaced with a Vbeam PDL (Syneron Candela Corp.) because production of the SPTL-1b was discontinued. The SPTL-1b PDL was used without dynamic cooling at a wavelength of 585 nm, a pulse duration of 450 μs, an energy fluence of 6.0–10.0 J/cm^2 [1], and a shot diameter of 7 mm. The Vbeam PDL was used without dynamic cooling at a wavelength of 595 nm, a pulse duration of 450 μs, an energy fluence of 6.0–8.0 J/cm^2 (8.0 J/cm^2 is the maximum energy fluence for a pulse duration of 450 μs), and a shot diameter of 7 mm. The Ruby Z-1 QsRL device (JMEC, Tokyo, Japan) was used at a wavelength of 694 nm, pulse duration of 20 ns, and energy fluence of 6–10 J/cm^2. The energy fluence was individualized according to color. In patients with hairy CMNs, each treatment was performed after shaving the hair from the lesion or hair removal with electrolysis. The hair removal with electrolysis was used because of two reasons. One is, when there is still pigmentation on the lesion, laser hair

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✉ Emi Funayama
emi-f@bc.iij4u.or.jp

[1] Department of Plastic and Reconstructive Surgery, Faculty of Medicine and Graduate School of Medicine, Hokkaido University, Kita-15, Nishi-7, Kita-ku, Sapporo 060-8638, Japan

[2] Department of Plastic and Reconstructive Surgery, Fukushima Medical University, Fukushima, Japan

[3] Department of Plastic and Reconstructive Surgery, Aichi Medical University, Nagakute, Aichi, Japan

removal treatment may cause epidermal thermal trouble; the other is, electrolysis hair removal may have a potential to burn nevus nests around the hair follicle. Moreover, COL-1015 CO_2 ablative laser (NIDEK, Aichi, Japan) therapy (less than three passes per round) followed by the highest-powered QsRL was used for cases with remaining pale color after multiple rounds of combined laser treatment using the PDL and QsRL. The COL-1015 CO_2 ablative laser was used in computerized scanner mode with a uni-(ultra) pulse at an output power of 7–10 W and a pulse duration of 700–1000 μs. This mode allows uniform depth ablation within the programed area. Informed consent was obtained from all patients. This study was approved by the institutional review board of the Hokkaido University Hospital.

The clinical response at ≥ 1 year after the final treatment was evaluated using the 5-point scale of Klimer and Lee [1, 2] as follows: poor (no change, with ≤ 25% lightening), fair (slight improvement, with 26–50% lightening), good (improvement, enabling differentiation from the surrounding healthy skin, with 51–75% lightening), excellent (difficulty in differentiating the lesion from the surrounding healthy skin, with 76–95% lightening), and clear (near-complete disappearance of the lesion, with ≥ 95% lightening).

Results

Multiple rounds of treatment were needed in all patients. To obtain maximum improvement, at least five (average 9.1) rounds of combination laser treatment were required. The mean number of rounds of laser treatment required to achieve skin lightening was 10. Re-epithelialization was completed within 10–14 days after treatment. Patients with residual pale-colored pigmentation after multiple rounds of combined laser therapy underwent CO_2 laser treatment followed by QsRL treatment. Such touch-ups were performed in five patients (on the lip, eyebrow, malar region, eyelid, and limb). Of the 19 patients, 78.9% showed clear to good responses (Figs. 1, 2, 3, and 4). Those patients showed no evident recurrence within a follow-up of at least 1 year after last laser therapy. Flat scarring with an abnormal skin texture was found in each excellent to good case after treatment. Partial hypertrophic scarring was seen in one patient with a CMN on the lower lip. No case of malignant transformation was observed.

Discussion

Treatment modalities for medium-sized CMNs are focused on the early removal of as many melanocytes as possible. Although surgical excision may be more appropriate for certain lesions, laser therapy is an effective and less invasive modality when surgical excision is not possible or recommended. Ablative and non-ablative lasers have been used for the treatment of CMNs [3–8]. Here, besides Q-switched pigment-specific lasers, we focused on PDLs, which are commonly used for vascular lesions and are highly absorbed by melanin and hemoglobin. The pulse duration is longer than that of Q-switched lasers, which can have non-specific photothermolytic effects on the surrounding non-pigmented nevus cells. Thus, PDLs may reduce the number of nevus cells. Laser absorbance depends on the intensity of the melanin content; thus, a pale-brown lesion would not be expected to respond as well as a dark black lesion. In patients with a low melanin intensity (pale-colored CMN) after multiple rounds of combined laser therapy using a PDL and QsRL, another treatment option may be considered. The CO_2 laser prior to the development of pigment-specific lasers was reported to be effective for superficial intradermal nevi [4, 8] and might be a good next step option. In our study, five patients with remaining light pigmentation after multiple rounds of combined laser therapy using a PDL and QsRL had good responses following a few rounds of therapy with CO_2 laser ablation and QsRL treatment. A combination of QsNd:Yag and ablative laser was

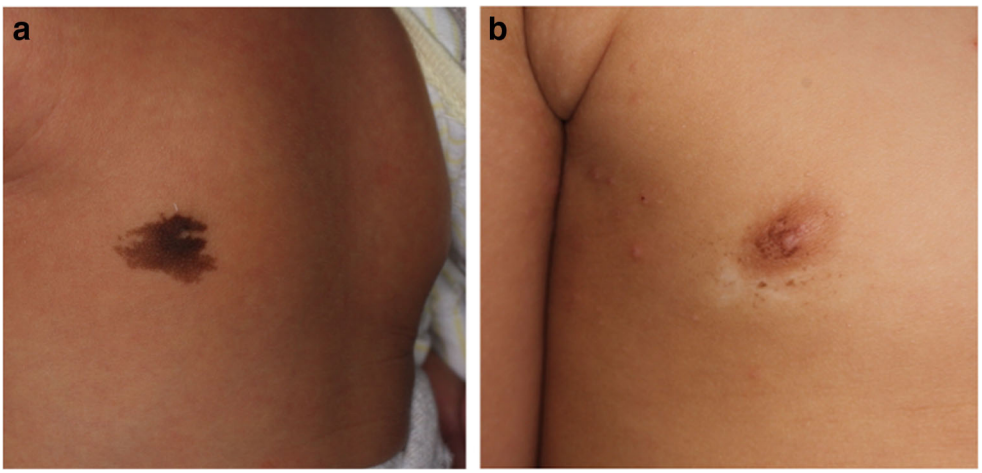

Fig. 1 A 1-month-old female with a congenital melanocytic nevus on her nipple and areola who underwent (5 rounds) combined PDL plus QsRL treatment. **a** Before treatment and **b** 3 years after the last round of treatment

Fig. 2 A 13-month-old male with a congenital melanocytic nevus on his eyebrow who underwent combined PDL plus QsRL treatment. Every laser treatment performed after shaving hair on the lesion. Additionally, he underwent CO_2 laser treatment followed by QsRL treatment two times for residual pale-colored pigmentation. **a** Before treatment and **b** 2 year after the 9th round of treatment. After laser treatment, the patient underwent selective hair removal with electrolysis

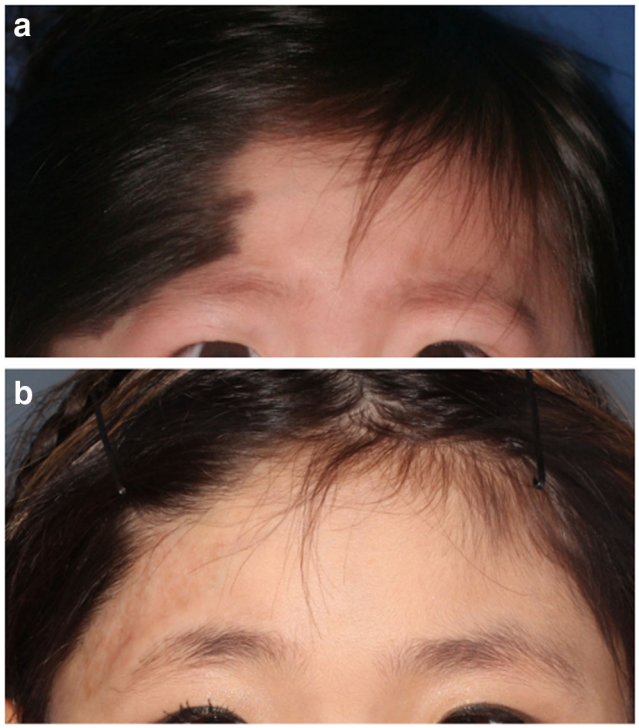

Fig. 4 A 14-month-old female with a congenital melanocytic nevus on her forehead who underwent combined PDL plus QsRL treatment. Each treatment was performed after shaving the hair from the lesion or hair removal with electrolysis. **a** Before treatment and **b** 3 year after the 11th round of laser treatment

shown to be effective [4]. However, nevus cells located in the deep layer could not be treated. A combination of QsNd:Yag and ablative laser might be more appropriate for superficially located nevus cells or in the treatment of newborn babies with very thin skin. Hence, we consider combination therapy with PDL and Q-switched pigment-specific lasers to be preferable as a first line of treatment for CMNs in cosmetically and functionally sensitive locations.

Notably, we observed a moderate downward-trending linear relationship between the age at laser initiation and treatment efficacy (Online Resource 1). Age at initial combined laser treatment was associated significantly with treatment response. The earlier the laser therapy was started, the more responsive the patient was to it. This result coincides with those of previous reports [3, 4]. Nevus cells might migrate deeper with increasing age [9].

Controversy exists concerning the risk of malignant transformation of CMNs because of a lack of valid data regarding the incidence of malignant changes [10]. A recent review estimated the combined lifetime risk of cutaneous and extracutaneous melanomas to be 2–3% [10]. Moreover, even after surgical treatment, malignant melanoma development might

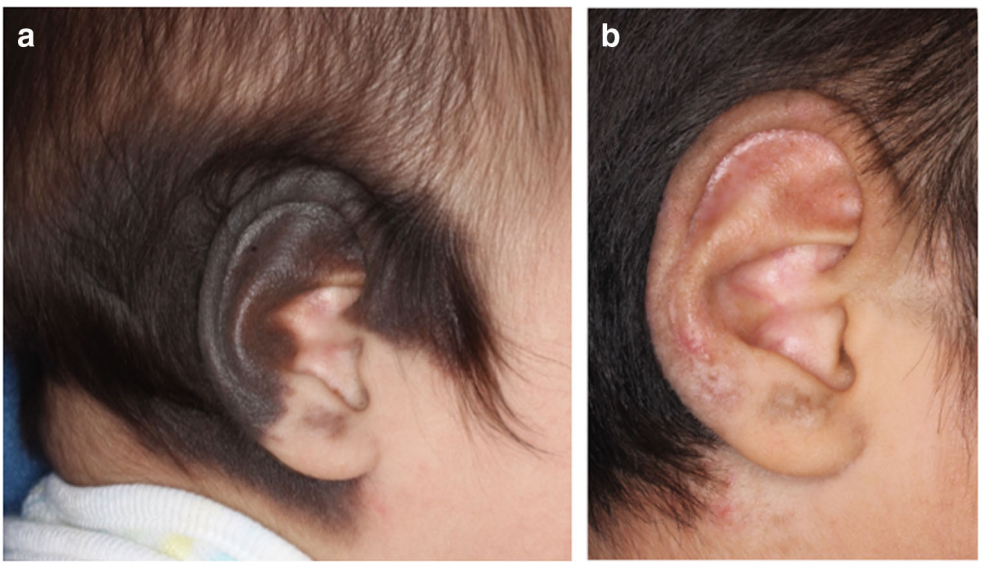

Fig. 3 A 5-month-old male with a congenital melanocytic nevus on his auricular region who underwent combined PDL plus QsRL treatment. **a** Before treatment and **b** 1 year after the 5th round of laser treatment

not be avoided [11]. Considering that the sheer number of melanocytes is responsible for the increased malignant potential [12, 13], the destruction of melanocytes using lasers may reduce the risk of melanoma. No evidence suggests that any form of treatment, including laser therapy, affects the risk of melanoma [14].

Our protocol of combined laser therapy for cosmetically sensitive locations greatly improved the patients' cosmetic appearance and function. Although our approach requires multiple rounds of treatment, it may be an effective option for medium-sized CMNs in cosmetically sensitive body regions. Short- and long-term monitoring for malignant melanoma development and color recurrence should also be performed.

Conclusion

We applied combined PDL and QsRL therapy to medium-sized CMNs in cosmetically sensitive locations on the body. CO_2 ablative laser therapy followed by the highest-powered QsRL was used to treat patients with remaining pale-colored pigmentation after multiple rounds of combined laser therapy using PDL and QsRL. This combined approach greatly improved the patients' cosmetic appearance. Despite its limitations, such as the need for multiple rounds of treatment, this combined laser therapy may be an effective treatment for cosmetically sensitive locations.

Compliance with ethical standards

Informed consent was obtained from all patients. This study was approved by the institutional review board of the Hokkaido University Hospital.

Conflict of interest The authors declare that they have no conflict of interest.

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