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Combination of Non-Ablative Fractional Laser with Q-Switched Laser for the Treatment of Becker's Nevus: Efficacy and Limitations

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Becker's nevus (BN) is a benign hamartoma that may present as a distressing cosmetic problem. The treatment of BN poses a significant challenge as current therapeutic modalities are suboptimal and have an increased risk of adverse effects, such as scarring and dyspigmentation. We present the use of non-ablative fractional laser therapy combined with Q-switched Nd:YAG laser as a possible therapeutic option for BN treatment and review relevant literature to discuss its efficacy and limitations.

Keywords: Epidermal nevus, Lasers, Nevus, pigmented

INTRODUCTION

Becker's nevus (BN) is an uncommon pigment disorder characterized by unilateral hyperpigmented patches distributed mostly on the proximal upper extremities, with or without hypertrichosis. Generally, its cosmetic appearance can induce substantial social and psychological distress. Current therapeutic modalities include intense pulsed light (IPL)[1], Q-switched (QS) ruby, erbium:yttrium-aluminum-garnet (Er:YAG), neodymium:YAG (Nd:YAG)[2], and long-pulsed alexandrite lasers[3]. While laser treatments are relatively safe, the results are often disappointing or even counterproductive. Therefore, combinations of different lasers have been suggested to improve treatment outcomes[4]. Herein, we report a case of BN on the anterior chest that was successfully treated with a combination of 1,064-nm QS Nd:YAG laser and non-ablative fractional laser therapy (FLT).

CASE REPORT

A 20-year-old man presented to our clinic with a hyperpigmented patch on his anterior chest (Fig. 1A). The lesion was first recognized by the patient at the age of ten, which subsequently increased in size during puberty. There was no history of previous treatment. A punch biopsy was performed, and the lesion was histologically confirmed as BN. The treatment was initiated by removing the hair over the lesion with IPL (Icon^{TM} MaxR^{TM}; Cynosure, Inc., Westford, MA, USA), which has an output wavelength range of 650~1,200 nm, pulse duration of 25 ms, and fluence of 32 J/cm^2. After six sessions delivered 6 weeks apart, complete hair removal was achieved (Fig. 1B). Then treatment for hyperpigmentation was initiated with 1,064-nm QS Nd:YAG laser (RevLite; HOYA ConBio, Freemont, CA, USA) with a spot size of 6 mm, fluence of 5.0 J/cm^2, and pulse rate of 10 Hz. However, after 15 sessions of treatment, the improvement was minimal. Thus, we decided to supplement the treatment with 1,550-nm non-ablative FLT (Sellas; Dinona Inc., Seoul, Korea). We arbitrarily

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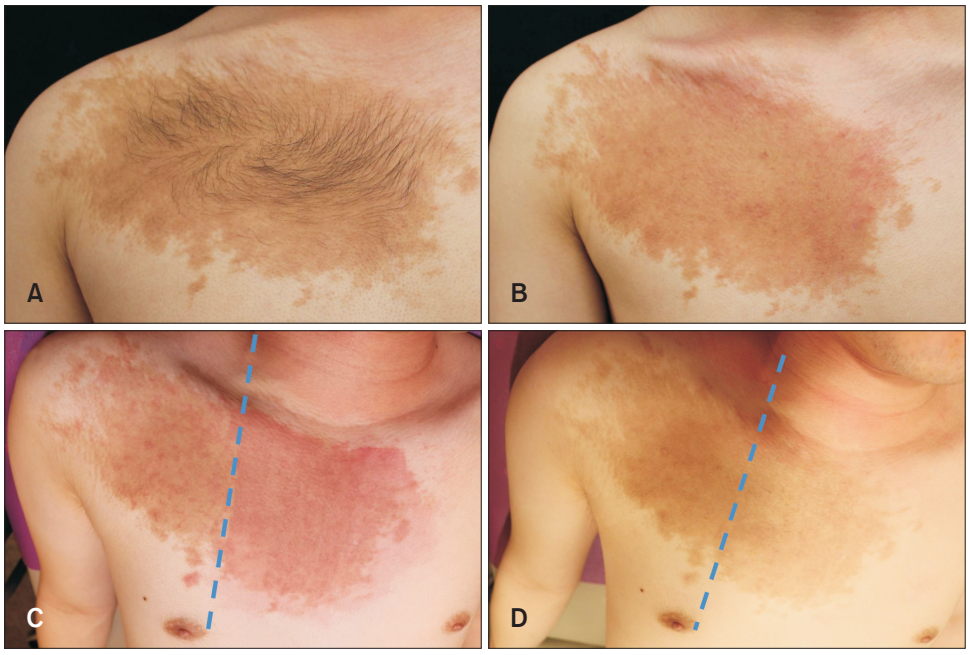

Fig. 1. Treatment response of the patient with a hyperpigmented patch with terminal hair on the anterior chest (Becker's nevus). (A) Before treatment. (B) After six sessions of laser hair removal using the Icon™ MaxR™ IPL system (Cynosure, Inc., Westford, MA, USA), complete hair removal is achieved. (C) The lesion is arbitrarily split into two halves (blue line) and fractional laser therapy (FLT) was applied to the medial side. Moderate to severe post-procedure erythema and edema are noted on the area treated with FLT. (D) After four sessions of treatment, FLT treated area in the medial half shows marked improvement compared to the distal half where only the 1,064-nm Q-switched Nd:YAG laser was delivered.

split the lesion into two halves (Fig. 1C, blue line), and FLT was added only on the medial half. In each session, the treatment was performed with a fluence of 10 mJ/cm^2 at densities of 254 microscopic treatment zones (MTZ/cm^2) in three passes. After FLT, the whole lesion was treated with 1,064-nm QS Nd:YAG laser. After four sessions delivered 4 weeks apart, the area where FLT was added showed marked improvement compared to that where only 1,064-nm QS Nd:YAG laser was delivered (Fig. 1D). Consequently, the whole lesion was treated with non-ablative FLT combined with 1,064-nm QS Nd:YAG laser, and the treatment is ongoing. No side effects have been observed yet during the treatment. After the last treatment shown in Fig. 1D, additional 2 sessions of treatment were done. Slow but continuous improvement is observed, and no recurrence or aggravation of the lesion has been observed until now. We received the patient's consent form about publishing all photographic materials.

DISCUSSION

BN should be differentiated from congenital smooth muscle hamartoma (CSMH) which shared similar clinicopathological characteristics. CSMH usually presents at birth or early infancy, while BN is usually diagnosed at puberty. Also, CSMH has less prominent pigmentation but more hypertrichosis and many cases display pseudo-Darier's sign, temporary induration after rubbing the lesion. Histopathologically, BN shows epidermal changes with occasional dermal smooth muscle proliferation but does not show bundle-like structures that are often seen in CSMH. CSMH usually does not require aggressive treatment. On the other hand, laser treatments that target hypertrichosis and pigmentation can be effective in preventing progression of BN[5,6].

As mentioned above, in the histopathology of BN, the epidermis commonly shows acanthosis, papillomatosis, keratotic plugging, irregular elongation, and fusion of the rete ridges, with increased melanin content of the keratinocytes. The basal cell layer is hyperpigmented, and the melanophages may be present in the papillary dermis[7]. Further, smooth muscle proliferation are may be evident within the reticular dermis. Therefore, elimination of epidermal changes, hyperpigmentation, and melanophages in the papillary dermis, along with tissue remodeling of the reticular dermis, are essential for successful treatment.

QS lasers, such as 694-nm ruby, 1,064-nm Nd:YAG, and 755-nm alexandrite, selectively damage the epidermal and dermal melanin without removing the entire epidermis. However, they exhibit limited clinical efficacy for BN treatment, requiring multiple treatment sessions, and recurrences are common[2]. Because of their pigment specificity, other epidermal and dermal changes, such as hyperkeratosis, elongation of rete ridges, and smooth muscle proliferation, in BN often

persist after repeated treatments[2,8].

Conversely, ablative lasers, such as Er:YAG laser has been suggested to be superior to QS lasers[2]. Histological evaluation after 2 years of treatment with Er:YAG demonstrated normalization of the epidermis with improvement in the elongated rete ridges, melanocytic proliferation, and basal/dermal hyperpigmentation. However, Er:YAG induces superficial skin resurfacing by causing thermal damage to the surrounding tissues, leading to the removal of the epidermal and dermal lesions. Therefore, crust formation and transient erythema are commonly encountered. Occasional side effects such as temporary hypo- and hyperpigmentation, secondary infection, or even defective scarring may occur[2]. Treatment outcomes and safety are also highly dependent on the operating physician.

With the development of laser technology, various lasers with wavelengths ranging from 504 to 10,600 nm have been used to treat BN, resulting in mixed clinical outcomes. To minimize side effects and maximize treatment results, combining different types of lasers has been suggested because each laser has different wavelengths, which determine the penetration depth as well as preferential absorption by specific substance or tissue[4]. In the present case, we utilized three different types of light-based treatment modalities to treat BN: first, we utilized IPL for hair removal; second, for the remaining pigmentation, we used the 1,064-nm QS Nd:YAG laser; however, because the improvement was minimal, we added non-ablative FLT. This combination of lasers led to a marked improvement in the pigmentation.

Non-ablative FLT creates a dense pattern of epidermal and dermal microscopic thermal wounds and epidermal repair. A few previous literatures have reported that BN has been successfully treated using combination therapy or monotherapy with non-ablative FLT (summarized in Table 1)[9,10] because of its ability to affect both the epidermis and deep dermis. Histological evaluation after FLT demonstrates the formation of microscopic epidermal necrotic debris (MENDs), which

Table 1. Summary of clinical observations of non-ablative fractional laser therapy (FLT) for Becker's nevus

Case	Race	Treatment parameter	Outcome	Recurrence	Reference no.
Long-pulsed Nd:YAG and non-ablative fractional erbium doped (1,550 nm)+topical hydroquinone					
2	Hispanic	Patient 1. Nd:YAG: 10 J/cm^2, 3~5 ms, 2 sessions at 8 week intervals to remove hair → Erbium-doped fiber laser (1,550 nm): 9~40 mJ, 8 passes, 8 sessions at 4~8 week intervals Patient 2. Nd:YAG: 14 J/cm^2, 20 ms, 40/40 dynamic cooling, 3 sessions at 4~8 week interval → Erbium-doped fiber laser (1,550 nm): 30~45 mJ, 20% coverage, total 1.74~2.10 kJ, 8 passes, 5 sessions at 4~8 week intervals	Over 75% clearance in both patients	Sustained results in both patients (10 months, 3 months follow-up)	9
Non-ablative fractional erbium doped (1,550 nm)					
2	White	Erbium-doped fiber laser (1,550 nm): 6~10 mJ, 250~254 MTZs/cm^2, 8~10 passes, 5~6 sessions at 4-week intervals	Over 75% clearance in both patients	Sustained results in both patients (6 months, 3 months follow-up)	10
Our case					
1	Asian	IPL: 32 J/cm^2, 25 ms, 6 sessions at 6-week intervals to remove hair → 1,064-nm Q-switched Nd:YAG laser: 6 mm spot size, 5 J/cm^2, 10 Hz, 15 sessions at 2 week intervals → Erbium-doped fiber laser (1,550 nm): 10 mJ, 254 MTZs/cm^2, 3 passes, 4 sessions at 4 week intervals	Over 50% clearance and treatment is ongoing	Treatment is ongoing. No recurrence has been observed until 2 months after the start of the treatment	

MTZ: microscopic treatment zones, IPL: intense pulsed light, Nd:YAG: neodymium:yttrium-aluminum-garnet.

contain melanin pigment and degenerated epidermal and dermal components. These MENDs are ultimately shed from the epidermis within 7 days, thereby facilitating the transepidermal elimination of the epidermal and dermal melanin, the so-called "melanin shuttle." We also believe that the additional use of pigment-specific QS laser accelerated the transepidermal elimination of the melanin. Additionally, FLT generates a wound healing response in the dermis and, therefore, may act on BN by removing the epidermal pigment and remodeling the dermal collagen[11].

However, there are some limitations to the combination treatment with non-ablative FLT and QS Nd:YAG laser for BN. One of the most prominent features of BN is that BN is a type of epidermal nevus (EN), which exhibits significant epidermal abnormalities, such as acanthosis, papillomatosis, and keratotic plugging[12]. To improve these epidermal changes, several types of ablative lasers have been successfully used to treat various EN[13]. Hence, it is plausible that to a certain degree, epidermal ablation is required for the complete removal of BN lesions. In our patient, despite much improvement in the pigmentation, areas with palpable plaques remained. These lesions seem to reflect unresolved abnormalities in the epidermis. This seems to be a major limitation of non-ablative FLT combined with QS Nd:YAG laser. Thus, we will need to consider using other ablative FLTs in these remaining areas and compare the results in the future.

BN is notorious for high recurrence rate after treatment with laser devices[14]. Several factors have been suggested to contribute to the high recurrence rate. For instance, hormonal factors and higher hormonal receptor expression may contribute to repigmentation of the lesion[12]. Others have suggested that repigmentation is due to the persistence of deep hair-follicle melanocytes[15]. Kopera et al.[16] observed that only the superficially located pigment was selectively damaged and that melanocytes in adnexal structures were preserved after a single treatment of BN with QS ruby laser. Similarly, Jung et al.[15] has reported that residual live BN melanocytes were observed after QS alexandrite laser irradiation, and suggested that these laser-resistant BN melanocyte can be one of the causative factors of post-laser repigmentation of BN. In the previously reported cases of BN treated with non-ablative FLT, no recurrence or repigmentation was observed during 3 to 10 months of follow-up after treatment. In our case, although the treatment is ongoing, we did not observe any repigmentation of the lesion at least for 2 months after the start of the treatment. Although, these few results by no means prove that treatment with non-ablative FLT show lower recurrence rate of BN compared to other lasers, it would be interesting to evaluate the histologic changes and viability of melanocytes in BN lesion after non-ablative FLT laser treatments in the future.

Despite these limitations, the present case of split-lesion treatment demonstrated that adding FLT to 1,064-nm QS Nd:YAG laser than the latter alone was more effective in treating BN. Since there is only a few case reports on the use of non-ablative FLT for the treatment of BN, additional controlled studies with larger sample size and longer follow-up periods are warranted to evaluate the efficacy of combination treatment using fractional resurfacing and to determine optimal treatment settings for the treatment of BN.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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