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Laser Therapy of Pigmented Lesions: Pro and Contra

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SUMMARY Although frequently performed, laser removal of pigmented lesions still contains certain controversial issues. Epidermal pigmented lesions include solar lentigines, ephelides, café au lait macules and seborrheic keratoses. Dermal lesions include melanocytic nevi, blue nevi, drug induced hyperpigmentation and nevus of Ota and Ito. Some lesions exhibit both an epidermal and dermal component like Becker's nevus, postinflammatory hyperpigmentations, melasma and nevus spilus. Due to the wide absorption spectrum of melanin (500-1100 nm), several laser systems are effective in removal of pigmented lesions. These lasers include the pigmented lesion pulsed dye laser (510 nm), the Q-switched ruby laser (694 nm), the Q-switched alexandrite laser (755 nm) and the Q-switched Nd:YAG laser (1064 nm), which can be frequency-doubled to produce visible green light with a wavelength of 532 nm. The results of laser therapy are usually successful. However, there are still many controversies regarding the use of lasers in treating certain pigmented lesions. Actually, the essential question in removing pigmented lesions with lasers is whether the lesion has atypical features or has a malignant potential. Dermoscopy, used as a routine first-level diagnostic technique, is helpful in most cases. If there is any doubt whether the lesion is benign, then a biopsy for histologic evaluation is obligatory.

KEY WORDS: laser, pigmented lesions, nevi

INTRODUCTION

In recent years, lasers have been frequently successfully used in treating various pigmented lesions. The results are usually successful. However, there are still many controversies regarding laser therapy of certain pigmented lesions.

In general, pigmented lesions are categorized by location of pigment in three groups: epidermal, dermal and mixed (epidermal/dermal) pigmented lesions. Epidermal pigmented lesions include solar lentigines, ephelides, café au lait macules and seborrheic keratoses. Dermal lesions include melanocytic nevi, blue nevi, drug induced hyperpigmentation and nevus of Ota and Ito. Some lesions exhibit both an epidermal and dermal component:

Acta Dermatovenerol Croat
2010;18(3):185-189

Becker's nevus, postinflammatory hyperpigmentations, melasma and nevus spilus (1).

Melanin is the main natural cutaneous pigment to be considered when dealing with pigmented lesions. It is contained in melanosomes within the epidermis and dermoepidermal junction (melanin horizontal distribution). Also, it is highly concentrated in hair follicles and vertical growth components of nevomelanocytic nevi (2).

To obtain selective photothermolysis of melanin, pigmented lesions must be treated with laser light having a wavelength appropriate to absorption characteristics of melanin. Due to the wide absorption spectrum of melanin (500-1100 nm), several laser systems are effective in the removal of pigmented lesions: pigmented lesion pulsed dye laser (510 nm), Q-switched ruby laser (694 nm), Q-switched alexandrite laser (755 nm) and Q-switched Nd:YAG laser (1064 nm), which can be frequency-doubled to produce visible green light with a wavelength of 532 nm. Lasers which emit green light with shorter wavelengths penetrate optically very little into skin layers and require relatively less energy to produce irreversible thermal damage to melanosomes; therefore, they should be selected to treat epidermal lesions. Lasers that emit red light with longer wavelengths are more successful in treating deeper dermal melanosomes, i.e. dermal lesions (3).

Selective pigment destruction depends not only on wavelength but also on pulse duration. Submicrosecond laser pulses are required for selective disruption of melanosomes because their thermal relaxation time ranges from 250 to 1000 nanoseconds, depending on their size. Therefore, short-pulsed lasers with pulse durations from 40 to 750 nanoseconds are used, whereas longer pulse durations, in millisecond domain, do not cause specific melanosome damage. At these pulsewidths, laser-tissue interaction produces a combination of photothermal and photomechanical effects (4). In addition, shorter wavelengths (<600 nm) require relatively less energy fluences, while at longer wavelengths higher fluences are required to produce an efficient photothermal reaction (5).

Pigmented lesion dye laser

The pigmented lesion dye laser emits light of a 510 nm wavelength and a pulse duration of 300 nanoseconds, which enables targeting superficial melanosomes. This laser is effective in the treatment of lentigines and other epidermal pigmented lesions. Up to 50% of patients develop purpura due to absorption of laser energy by oxyhemoglobin. A fine crust typically forms over the laser treated area and peels off after one week (6,7).

QS ruby laser (QSRL)

The Q-switched ruby laser emits visible red light at a wavelength of 694 nm and pulse duration of 25-40 nanoseconds. This wavelength is strongly absorbed by superficial melanin, which can lead to permanent hypopigmentation and depigmentation in darker-skinned individuals. The absorption of ruby laser energy by hemoglobin is minimal. After treatment, the crust is formed at the site of laser irradiation and peels off after several days (8,9).

QS alexandrite laser

This laser operates at a wavelength of 755 nm and a pulse duration of 50-100 nanoseconds. Its longer wavelength permits deeper tissue penetration and less unwanted hypopigmentation compared with QSRL. Postoperative healing is similar to other QS pigment-specific lasers, but is considered less severe (10).

QS Nd:YAG laser

It emits 1064 nm light, but it can also be frequency-doubled using a potassium diphosphate crystal to produce visible green light with a wavelength of 532 nm (a pulse duration of 5-10 nanoseconds). Melanin has a strong affinity for 532 nm green light, whereas the longer 1064 nm red wavelength penetrates deeper in the dermis but with a lower melanin absorption coefficient. After the use of smaller spot sizes, tissue splatter usually occurs, leading to crusting that may take several weeks to fully resolve (11,12).

EPIDERMAL PIGMENTED LESIONS

Epidermal pigmented lesions can be effectively treated with both shorter wavelengths (green light lasers) and longer wavelengths (red light lasers).

Ephelides are very difficult to treat because they recur frequently after laser therapy. Before treatment, bleaching agents like hydroquinone may be used (1,13).

Among all pigmented lesions, **lentigines** show probably the best response to laser therapy. They typically fade by 50% or more after one treatment session. Complete eradication is usually observed after three treatments in 6- to 8-week intervals (14,15).

Café au lait macules respond variably to laser

Acta Dermatovenerol Croat
2010;18(3):185-189

therapy and recur in as many as 50% of patients. Repeated treatments over a long period (several months or even years) are needed to achieve maximal clearing of the lesion. Repigmentation occurs from adjacent untreated melanocytes; therefore, the entire lesion should be treated at each session (1,13).

MIXED EPIDERMAL/DERMAL PIGMENTED LESIONS

Laser removal of **Becker's nevus** is difficult. Again, there is a variable response and a high rate of recurrences. Long pulsed lasers may prove most effective in treating both epidermal and follicular melanocytes (13,16).

Postinflammatory hyperpigmentations are often resistant to laser treatment. Multiple sessions are required to assess a slight improvement.

Melasma is often a therapeutic problem. Pigment can be located in epidermis, or in dermis, or in both of them. Similar to other traditional methods (sunscreen, retinoic acid, hydroquinone and chemical peels), laser treatment produces variable results. Sometimes even worsening of the condition is observed (1,13,17).

Nevus spilus is a typical café au lait macule with multiple darkly pigmented speckles within it. These often represent either compound or junctional nevi. There are several reports of dysplastic nevi developing within nevus spilus and of melanoma arising within these lesions. These facts make laser treatment doubtful in this indication. However, it is recommended to make biopsy in case of any atypical appearing pigmented lesion within nevus spilus. Multiple laser sessions are needed to remove the unwanted pigment (18,19).

DERMAL PIGMENTED LESIONS

The use of pigment-specific lasers to remove congenital and acquired melanocytic nevi remains controversial. It is necessary to emphasize that the primary treatment of choice for nevus removal is surgical excision followed by histopathologic examination. Laser therapy has been reserved for the lesions located at cosmetically or functionally sensitive areas where surgical excision might leave a disfiguring scar.

Acquired melanocytic nevi should always be carefully evaluated clinically before laser treatment. Benign junctional melanocytic nevi show good therapeutic response to relatively short wavelengths, while deeper compound or dermal types of melanocytic nevi require longer wavelengths, higher fluences and longer pulsewidths, and still tend to recur (1,13,20,21). In some treated nevi, irregular repigmentation is observed after laser treatment, termed pseudomelanoma. In these cases, excisional biopsy must always be performed, followed by dermopathology. For the above-mentioned reasons, surgical excision must be considered as the treatment of choice in these indications, while one must keep in mind the possible risks when treating melanocytic nevi with lasers (22,23).

Congenital nevi may pose a risk of melanoma that increases with the size of lesion. Therefore, surgical excision is primary treatment of choice, while laser treatment should always be remembered as a secondary option performed in an attempt to either reduce the pigment or to remove associated hair growth. Laser treatment is associated with several problems: variable response, permanent hypopigmentation, local scarring and rarely achieved complete clinical response. Additionally, incomplete nevus removal may be followed by pseudomelanoma development, and early melanoma lesions can easily be mistaken for benign spots.

Early in life, ablative lasers may be used as an alternative to mechanical dermabrasion, for the treatment of larger congenital nevi, especially when located in critical areas (periorbital, perigenital region) (24-26).

The longer wavelength red-light lasers can successfully remove **blue nevi**. However, it must be kept in mind that differential diagnosis of blue nevi includes melanoma. Therefore, surgical excision is the safest method in this indication (27).

Nevus of Ota and Ito show excellent therapeutic response to the longer wavelength red-light lasers. Although multiple treatment sessions are required, recurrences are unusual.

Drug induced hyperpigmentations also respond very well to laser therapy. They are most commonly induced by minocycline and amiodarone (1,13,18).

LASER THERAPY OF PIGMENTED LESIONS: ADVANTAGES AND DISADVANTAGES

The main advantage of laser therapy compared to conventional methods of treatment of pigmented lesions is in selective photothermolysis. Due to selective photothermolysis, thermal necrosis of the

Acta Dermatovenerol Croat
2010;18(3):185-189

melanosomes occurs with limited spread of coagulative necrosis to surrounding tissues. Therefore, the cosmetic result is often excellent with minimal risk of scarring. In addition, laser therapy is a very well tolerated procedure.

Unfortunately, there are some disadvantages. Primarily, therapeutic results are not always good. In many cases, repigmentation occurs as the consequence of deep localization of dermal pigment or stimulation of residual melanocytes in the adnexal or adjacent epithelium.

Actually, the most challenging issue is to determine when a lesion has atypical features or potential for malignant transformation. There are no long-term studies on the potential deleterious effects of laser exposure on nevomelanocytes. So it remains unclear whether laser induced thermal damage has long-term harmful effects on these cells. On the other hand, some authors believe that laser irradiation decreases the risk of malignant degeneration by removing the bulk of cells with intrinsic potential for malignant progression (1,7).

Therefore, dermoscopy is recommended in most cases. In all suspicious lesions fulfilling the criteria of atypia or initial malignancy, histology is mandatory (1,7,28).

CONCLUSION

Before treating pigmented lesions, it is extremely important to make a correct diagnosis. In cases of initially misdiagnosed melanomas, laser removal not only prevents appropriate and timely therapy but may also worsen the prognosis. Furthermore, it is necessary to select the proper laser according to the location of the pigment within the lesion; and understanding the effects of laser light on the skin is also crucial. Prior to treatment of pigmented lesions, in most cases dermoscopy is indicated. If there is any doubt whether the lesion is benign, then a biopsy for histologic evaluation is mandatory.

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