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ORIGINAL ARTICLE

Use of the pulsed infrared diode laser (904 nm) in the treatment of alopecia areata

MAKRAM WAIZ[1], ANMAR Z. SALEH[2], RAAFA HAYANI[1] & SAMAR O. JUBORY[1]

[1]*Department of Dermatology and Venereology, Baghdad Teaching Hospital, Baghdad, Iraq, and* [2]*Department of Medical Physics, College of Medicine, University of Baghdad, Baghdad, Iraq*

Abstract

Background. Alopecia areata is a rapid and complete loss of hair in one or several patches, usually on the scalp, affecting both males and females equally. It is thought to be an autoimmune disease which is treated with different modalities with variable success. Laser treatment of different wavelengths has been used in the management of this problem.

Objective. To study the effect of the pulsed infrared diode laser (904 nm) in the treatment of alopecia areata.

Methods. Sixteen patients with 34 resistant patches that had not responded to different treatment modalities for alopecia areata were enrolled in this study. In patients with multiple patches, one patch was left as a control for comparison. Patients were treated on a four-session basis, once a week, with a pulsed diode laser (904 nm) at a pulse rate of 40/s. A photograph was taken of each patient before and after treatment.

Results. The treated patients were 11 males (68.75%) and five females (31.25%). Their ages ranged between 4 and 50 years with a mean of 26.6 $\pm$ SD of $\pm$13.8, and the durations of their disease were between 12 months and 6 years with a mean of 13.43 $\pm$ SD of $\pm$18.34. Regrowth of hair was observed in 32 patches (94%), while only two patches (6%) failed to show any response. No regrowth of hair was observed in the control patches. The regrowth of hair appeared as terminal hair with its original color in 29 patches (90.6%), while three patches (9.4%) appeared as a white villous hair. In patients who showed response, the response was detected as early as 1 week after the first session in 24 patches (75%), while eight patients (25%) started to show response from the second session.

Conclusion. The pulsed infrared diode laser is an effective mode of therapy with a high success rate for resistant patches of alopecia areata.

Key words: *Alopecia areata, laser*

Introduction

Alopecia areata (AA) is a common a symptomatic skin disease characterized by a rapid onset of non-scarring hair loss in a sharply defined area. Any hair-bearing surface may be affected, especially the scalp (1). It affects 1% of the population and can occur at any age, most commonly in children. Although it is not life-threatening, the hair loss can be psychologically harmful (2,3).

The cause of AA is thought to be mainly attributed to an autoimmune process, which may be modified by genetic factors and aggravated by emotional stress (1). Many studies have documented an abnormal cell-mediated immune reaction in AA. There is an increased suppressor T-cell function in patients experiencing hair regrowth. Antibodies to pigmented hair follicles were detected by Western blotting in the sera of 100% of the AA patients examined compared with only 44% of normal controls (4).

The treatment of AA depends on the severity and extent of the disease. These include a topical irritant, and topical and intralesional steroids in mild cases. However, more aggressive therapy is used for severe cases such as systemic corticosteroids, immunosuppressive drugs and immune modulators (1).

The laser (light amplification by stimulated emission of radiation) has been used in the treatment of different skin diseases. The laser beam differs from the ordinary light by being coherent, monochromatic and polarized. It concentrates its beam in a defined position. These properties allow low-energy laser light to penetrate the surface without damage of the skin (5–7).

Correspondence: Professor Makram Al-Waiz, Department of Dermatology and Venereology, College of Medicine, University of Baghdad, PO Box 61269, Medical Collection Post Office, Postal Code 12114, Bab Almua'dham, Baghdad, Iraq. E-mail: raafahayani@yahoo.com

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Low-level lasers are generally smaller, less expensive and operate in the milliwatt (mW) range, 1–500 nW. The therapy performed with such lasers is often called low-level laser therapy (LLLT) or just 'laser therapy' and the lasers are called 'therapeutic lasers'. Several other names have been given to these lasers, such as the 'soft laser' and 'low-intensity level laser', whereas the therapy has been referred to as 'biostimulation' and 'biomodulation'. The latter term is more appropriate, since the therapy cannot only stimulate, but also suppress biological processes .No side effects were recorded from the biostimulative light energy directed to the body cells (8).

LLLT offers improved possibilities in the treatment of pain, wound healing, inflammation and oedema (8). LLLT has been used to treat patches of AA with variable success rates (9).

This study was designed to evaluate the effect of pulse infrared diode laser in the treatment of AA.

Materials and methods

This study included 34 resistant patches (which had not responded to different modalities of treatment) from 16 patients suffering from AA (scalp=14, eyebrow=six, beard=12, moustache=two) attending the Department of Dermatology and Venereology at Baghdad Teaching Hospital in the period between March 2004 and August 2004. The diagnosis of AA was performed clinically. All patients were thoroughly assessed in relevance to their condition. In patients with multiple patches, one patch was left as a control for comparison. Photographs were taken for each patient before and after the treatment.

Laser apparatus was a patented dental unit invented by Mario Scalvini, researcher of the Italian National Research Council, in 1989.

The laser used to treat the patches was a low-level invisible pulsed infrared diode laser (904 nm) wavelength, with a peak power of 150 W.

The treatment technique was carried out by multiple application of the laser in a series of circles in close contact with each other toward the center until the total area of the patch was treated. However, the overall treatment may not give an exact coverage of the total area because the application is prone to human error. The probe is 3 mm in diameter and treats the same area at each application (area=0.07065 cm^2), which takes about 5 seconds, from the pulsed laser of 40 pulses per second. The probe was in contact with the skin of the treated area. Patients were advised not to use any other treatment modality during the 1-month long laser therapy (four sessions, once weekly). All patients were assessed every week for hair regrowth and for any adverse effects such as itching, erythema and scaling. The final regrowth was categorized into two groups: first, those patches with complete hair growth with terminal hair; second, those patches with partial hair growth with villous hair.

The follow-up period was to 2 months after the last session. Calculation of the average power was carried out as follows:

$$\mathrm{PM} = \frac{\mathbf{P} \times \tau}{\mathbf{T}}$$

where PM=average power during the treatment time, owing to pauses between pulses; so the average power will be in the region of mW

P=is the peak power (in W)

τ=the time in which the laser radiation is actually emitted

T=the interval between one pulse and the other.

If P=150 W, τ =200 ns, T=25×10^{-3}, then the average energy is:

$$\mathrm{PM} = \frac{150 \times 200 \times 10^{-9}}{25 \times 10^{-3}} = 1.2\ \mathbf{mW}.$$

Results

The treated patients were 11 males (68.75%) and five were females (31.25%). Their ages ranged between 4 and 50 years with a mean of 26.6 $\pm$ SD of $\pm$13.8, and the duration of their diseases were between 12 months and 6 years with a mean of 13.43 $\pm$ SD of $\pm$18.34. In the treated patches (total of 34), regrowth of hair was observed in 32 patches (94%) while only two patches (6%) failed to show any response (Table I).

The regrowth of the hair appeared as terminal hair with its original color in 29 patches (90.6%), while three patches (9.4%) appeared as a white villous hair.

In patients who showed response, the response was detected as early as 1 week after the first session in 24 patches (75%), while eight patients (25%) started to show response from the second session onward.

Those patches (seven) that were left without treatment (as controls) showed no regrowth of hair at the end of treatment sessions performed to other patches on the same patients. They were eventually treated in the same manner.

During the treatment sessions no adverse effects were noticed. Also, between and after the sessions, patients did not complain of any side and unwanted effects.

The follow-up period showed no fall of hair in those patches that responded to treatment.

Discussion

AA is a non-scaring hair loss. Most authors tend to classify AA as an autoimmune disease (10). There are many modes of therapy including both topical and systemic agents acting through different

Table I. Details of alopecia areata patches and their response to treatment.

Location	No. of patients	No. of patches	Size			Gender		Results of treatment
			<2 cm^2	<4 cm^2	>7 cm^2	Male	Female	
Scalp	6	14	–	4	10	3	3	13 complete 1 partial (10 after 1 week)
Eyebrow	3	6	1	5	–	1	2	5 complete 1 failure (4 after 1 week)
Beard	5	12	1	5	6	5	–	11 complete 1 failure (8 after 1 week)
Moustache	2	2	1	1	–	2	–	2 partial (2 after 1 week)

mechanisms such as irritants, sensitizers, immunomodulators, and others (1,3,11).

The variable and uncertain natural history of AA accounts for the multiplicity of uncritical claims for a large variety of therapeutic procedures. However, it is fortunate that a variety of choices of therapy are available and all these work in favor through its irritant effect.

High-powered laser, mainly used for medical treatment, causes tissues to break after it is absorbed and turned into thermal energy. However, low-powered laser generates only a small amount of energy, of which a direct irradiation induces a slight somatic temperature change ranging between 0.1°C and 0.5°C. While high-powered laser is an expensive system that can raise output power up to 100 W, low-powered laser is a relatively low-priced system that only has a few milliwatts (12).

The biological effects of low-powered laser are widely reported, including anti-inflammation, pain reduction, wound healing, anti-edema, antibiosis, immunity and local blood circulation improvement (12,13).

Gundogan and his group reported two cases of AA showing homogenous and thick regrowth of hair after 11–12 treatment sessions with the 308 xenon chloride excimer laser and explained this as a result of the immunosuppressive action of the excimer laser which may induce T-cell apoptosis (14).

In this work, the treatment of AA with laser gave a very successful result and, importantly, most of the treated patients had previous unsuccessful, conventional, treatments for alopecia, some of them for more than 2 years, including treatment with irritants, corticosteroids, immunosuppressive drugs and PUVA for severe cases.

The laser used is pulsed, which gives high local energy but with less heating to the vicinity of the treatment. This means it can give effective energy and may cause local heating by giving high energy for a period during a pulse which, in turn, does not raise the temperature because heat dissipates between the pulses so there is no heat build-up, but it can influence the molecules which play an important role in clearing the disease.

The wavelength of laser used for treatment is of prime importance for producing an effect on a specific molecule. Researchers assumed that even though they did not know how low-powered laser increased hair follicles and tensile strength, it was agreed that one or more factors among improved micro-vascular circulation, reduced inflammation and increased cell energy in the form of ATP (adenosine triphosphatase) worked together (13).

Alopecia is considered to be an autoimmune disease, which means the immune system does not recognize 'self' from a non-self antigen. Discussion in the field of immunity is far too complex and beyond the scope of this work, but we ought to explain some possibilities that may be related to autoimmunity and the laser treatment of alopecia. It has been reported that one cause of the autoimmune disease is a hidden antigen which may be exposed to the self immune system, causing an immune reaction which may influence the hair follicles, including inflammation and a consequent effect on the blood supply in the capillaries (15). Some modification of the cell membrane caused by drugs or some kind of disease could make the cells unrecognized by the immune system as self (15).

Having known all the above factors, the cause of low-energy laser action on the disease is still unclear; however, the laser may alter either the cellular membrane or change the previously exposed 'hidden antigen' which may become hidden again.

In conclusion, the low-pulsed diode laser can be considered a promising mode of therapy in resistant patches of AA.

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