Epilation with Nd:YAG laser: a brief analysis of the technical application methods, results and pre- and post-treatment procedures.

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ABSTRACT

With the use of the so called "selective" lasers , it becomes possible to operate specifically on the melanin, as the absorbing target of unwanted hair.
The optimal pulse duration for laser epilation should lie between the TRT of the epidermis (1-2 msec) and the TRT of the follicle (10-50 msec). For the thermal destruction of the follicle containing melanine, the ideal laser energy should:
-be absorbed in a selective manner with respect to other chromophores;
-have a wavelength such to penetrate in depth and and reach the target to be treated;
-be sufficient to destroy tissue targets (in the hair the papilla, the follicular epithelium, the so called "bulge" and simultaneously the vascular support).
With this method the melanine and the follicular structures are "heated" in a preferential menner with actual saving of the adjacent skin structures.
There are numerous laser systems employed in the treatment of unwanted hair with variable results according to the source, procedures, phototype, and pigmentation of the hair to be treated. Most frequent side effects may be discomfort or slight burning sensation and unaesthetic pigmentary changes or scarring.
Our experience based on the treatment of 94 subjects over a 12 months time span using the Nd:YAG laser indicates wavelength of 1064 nm (SMARTEPIL 2 – DEKA M.E.L.A. – Italy), definitely efficient in obtain a greater penetration into the skin, reaching even the deepest follicles. A greater respect of the skin structures due to the minor absorption on the part of melanin results in a lower percentage of occurring possible side effects.

INTRODUCTION

Over recent years important progress has been made in the field of non-invasive epilation via the realisation of systems which use laser energy and non-coherent light. As with the treatment of vascular anomalies and pigmented lesions, *laser-assisted* hair removal is also based on the well-known theory of selective photothermolysis introduced by Anderson and Parrish in 1983 (1) and according to which, in order to obtain selective thermal damage it is necessary to ensure the existence of 3 conditions:

1) *The wavelength used must reach and be absorbed by the tissular chromophores.*
2) *The pulse duration or exposure time must be less than the heat attenuation time or the thermal relaxation time (TRT).*
3) *A "fluence", meaning an energy density capable of reaching and creating targeted thermal damage of the area to be treated.*

With the use of sub-cellular targeting laser, or so-called selective laser, it is possible to operate in a specific manner at the melanin level of the piliferous bulb of superfluous hairs.
Undesirable hair growth usually takes place in the three following conditions (2):
♦ *Hirsutism;*

♦ *Hypertrichosis;*
♦ *Aesthetic reasons.*

The optimal pulse duration for epilation should be long enough to allow the laser to position itself between the TRT of the epidermis (1-2 msec.) and the TRT of the follicle (10-50 msec). A pulse which is too long could risk causing heat damage to the contiguous structures with pigmentation changes or scarring. If we consider the process at a sub-cellular level, the melanin present in the hair shaft or follicle represents a chromophore missing in the derma that surrounds the follicle itself. Moreover, the number of melanocytes in dark hairs is greater than the number of epidermic melanocytes (3)(4). This allows for a significant extension of Anderson and Parrish's theory, and therefore for *the same chromophore, a greater pulse duration allows for cooling smaller targets similar to the chromophore itself during the pulse*. In this way, the ideal energy laser for the heat distribution of the follicle containing the melanin should:

- *be absorbed in a selective manner compared to other chromophores*
- *have a wavelength capable of penetrating in depth and reaching the target to be treated*
- *release sufficient photons for destroying the tissular targets (in our case, the papilla, the follicular epithelium, the so-called "bulge" and also the vascular support).*

This is how the melanin and therefore the follicular structures are "heated-up" in a preferential manner while still safeguarding the adjacent skin structures.

Rather than being continuous, hair growth is cyclic. According to today's biological models, the cells that give rise to the follicle are found in the so-called "*bulge area*"(5). It is during the initial anagen or 'anagen 1' phase that the "target" structures of the follicle like the papilla and the "*bulge area*" (near the erector muscle of the hair) with its own vascular system, are found closest to the skin's surface. At the same time it is precisely during this phase of the cycle, in which the metabolic exchanges are more intense, that the hair may be more sensitive to the heat effects of laser energy.

By now there are numerous laser systems used in the treatment of undesirable hairs, all with varying results depending on the type of energy source, the parameters used, the type of skin and the pigmentation of the hairs to be treated (6)(7)(8). The most frequent side effects may be discomfort or a slight burning sensation during the session, with erythematous or erythemate-pomphus lesions and un-aesthetic pigmentary changes or scarring.

The Neodymium:Yttrium-Aluminium-Garnet (Nd:YAG) laser, with a wavelength of 1064 nm allows for obtaining good clinical results with a low risk of side effects (8)(9). In this work we report our experience covering over 12 month's treatment of 94 subjects with Nd:YAG *long pulse* 1064 nm laser.

PATIENTS, MATERIALS AND METHODS

Throughout our work we used a Nd:YAG laser with the following features:
type of laser source: Nd:YAG (SMARTEPIL 2 – DEKA M.E.L.A. - Florence); a wavelength of 1064 nm; adjustable *single shot* frequencies and up to 6 Hz max; a pulse duration of up to 30 msec; handpieces with different spot-diameter: 2.5mm for vascular treatment; 5 and 7 mm for hair removal treatment; scanner system 5x5cm; adjustable fluences of between 16 and 200 J/cm^2.

The clinical protocol involved the following:
the enrolment of 94 subjects (68 females and 26 males aged from 20 to 50); an analysis of the patients on the basis of phototype and hair colour; an assessment of the areas to be treated (different areas treated: Face and neck, prolabium, bikini line, armpits, back, lower and upper limbs); depending on the previous points: setting of the device operating parameters (energy density, spot-size, frequency); treatments carried out hair by hair or with scanner system depending on the treated area; consecutive sessions a minimum of 15 days and a maximum of 45 days apart, depending on the patient and the area treated;

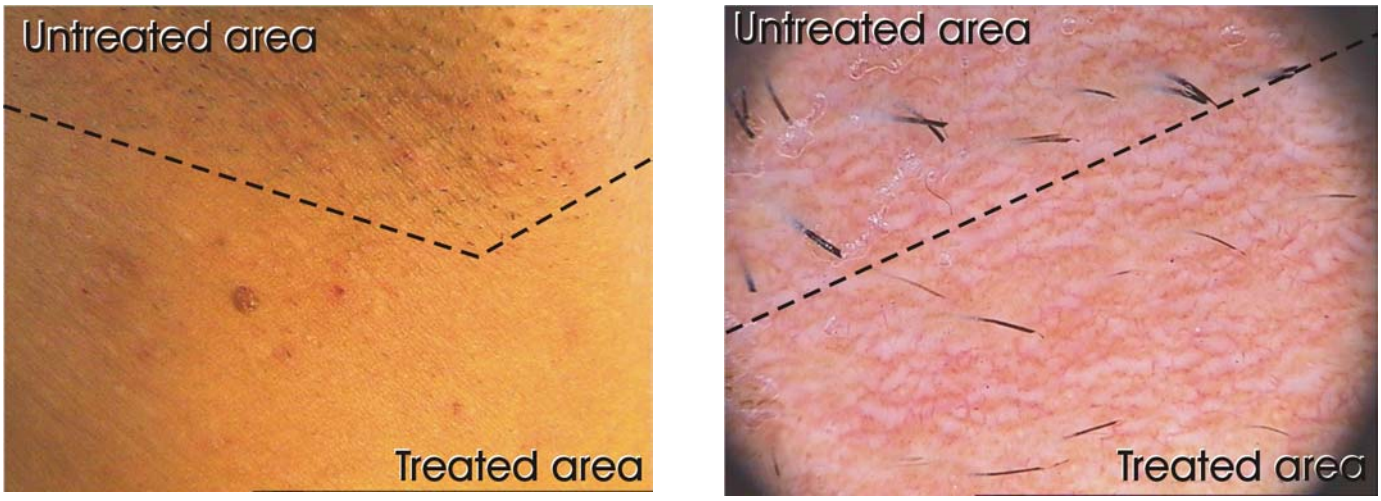

Fig. 1: Clinical case: neck area; hair differences (number of hair and their size) between treated and untreated area.

application of a soothing cream during and immediately after the laser treatment; evaluation of the tolerability of the laser application in terms of itching sensation, burning sensation, the presence of erythematous or erythemate-pomphus lesions; the prescribing of an antibiotic-type cream to be applied on the evenings of the treatment and for the three following days.

RESULTS

The results obtained can be summed up as follows:
a 20 to 30% reduction of the hairs with every treatment; a reduction in the thickness of the hairs that have not disappeared; average number of treatments: 5; maximum number of treatments: 8-15; a slight burning sensation during the treatment; slight, transitory (1-6 hours) erythemate-pomphus, perifollicular lesions; the absence of scarring and very rare cases of significant pigmentation (one single Iranian patient with phototype IV had hyperchromic lesions in the perioral area that lasted approximately 2 months).

CONCLUSIONS

The removal of undesirable hairs has always drawn the attention of operators in the cosmetological field. From the results of our experience, the need has arisen for putting the results obtained into perspective, especially with regard to the number of sessions and the patient's expectations. Apropos to which, we wish to stress the importance of the preliminary visit during which the patient must be informed in detail about the possibility of repeated sessions and the variable results considering the multitude of conditions. It is also important to point out that with the Nd:YAG laser, the type of wavelength combined with the pulse length and energy characteristics allow for greater patient-comfort from the point of view of associated pain and also a burning sensation. We did not observe any erythema or pomphus lesions that lasted longer than 12 hours and only in one case (patient with phototype IV) was there the onset of pigmentation changes that cleared up in approximately 2 months.
Our experience indicates a wavelength of 1064 nm and a pulse duration of 4-30 msec, as being efficacious in obtaining a greater penetration and reaching the deeper follicles, with a greater respect for the skin due to the lower absorption by the melanin, and consequently a lower incidence of side effects. The biological effects at the basis of the epilation process are undoubtedly connected to the selective absorption by the melanin of the follicle with the heat diffusion "conveyed" to the other follicular structures (*bulge*, papilla, microvessels), however they could also depend on the "direct" modifications of other tissular components (selective alteration of the microvessels?

Denaturation of the membrane lipoprotein?) and possible photoacoustic effects.
Further research is necessary in order to be able to accurately draw up a treatment plan that foresees with precision the number of sessions in relation to the multitude of variables that exist.

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