Chapter 8

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After completion of the experimental work and interpretation we came to know that several aspects of the field may be investigated. Depending upon the nature scope of the present work is divided into 9 following subtopics.

8.1 Hair removal by using diode laser

We studied the selective photo-thermolysis induced by diode laser. It is found that about 5 to 6 or more sessions are essential for reducing the number of hairs from different parts of the human body. Melanin is the prominent chromophore present in the hairs. Oxy-hemoglobin is the competent chromophore, with respect to melanin. (Fig. 8.1 page 202) Ruby laser is obvious choice at these wavelengths but due to its epidermal-melanin interference, it is not suited for removing Indian hairs. Nd:YAG laser also can be used for hair removal but for the Indian skin type IV to VI is it not suited properly. Alexandrite laser is another laser used for hair removal but its side effects are slightly more than the pulsed diode laser. We used 800 nm commercially available pulsed light sheer diode laser as we had to study its applications for hair reduction on Indian patients. There is no indigenously developed laser presently available in the market for Indian skin or hair type.

The fluence used for the laser hair removal depends upon factors like skin type, density of hairs, age of patient, type of hairs etc. It is better to perform laser hair removal treatment in the younger age, when the hair follicles
contain more melanin and hair reduction gives 100 % efficient results. In older age percentage of melanin decreases, hair bulb becomes thinner containing less melanin and laser energy is not absorbed by poor melanin hair bulb.

8.2 Choice of the lasers for hair removal

![Diagram showing absorption of various chromophores as a function of wavelength]

**Fig 8.1** The absorption of various chromophores as a function of wavelength³
Fig 8.2 Graphical study of absorption ratio of chromophores as a function of wavelength

From figure 8.2 the ratio of absorption between melanin and a chromophore like oxyhemoglobin is maximum i.e. 109 at 700 nm.
At the wavelength of ruby (694 nm) the ratio is 104. At 800 nm i.e. at diode laser wavelength the ratio is 43, also at 308 nm excimer laser wavelength, the ratio is 43. At the wavelength of Alexandrite laser the ratio comes out to be 80. At the wavelengths of dye laser (1.6), CVL (1.4), He-Ne laser (2.2), the ratio of melanin to hemoglobin is less and these lasers can not be used for hair removal. At Nd:YAG laser the ratio is 7.8. The efficiency of this laser is less and the laser may not give the desired results. At the pulsed UV nitrogen laser i.e. at 337.1 nm wavelength the ratio between melanin absorption to oxyhemoglobin is 15 and can be used as a reference wavelength and all the lasers having ratio greater than 15 can be used effectively for hair removal.\(^4\) Thus the lasers like ruby, alexandrite, pulsed diode laser, excimer and nitrogen laser can be used for hair removal.\(^5\)

Traditional hair removal methods have fallen behind with the use of laser or light based technology in the treatment of unwanted hairs due to their high efficacy, low side effects and less post treatment complications, faster results and most importantly better patient compliance. Laser hair removal has currently become very popular amongst patients, aestheticians and dermatologists. It is the best amongst all the available modalities for permanent hair reduction. However there is still a need to achieve permanent and complete hair removal for all skin and hair types. The photo-epilation technology is progressing rapidly with continued understanding of hair biology, laser physics,
skin optics and cooling mechanism and soon it will be possible to achieve permanent hair removal in all skin and hair types.

If the pulse width of the diode laser is reduced further, the effectiveness of the hair removal may be improved. If the hair detector is used along with the control system then the hairs may be reduced in one or two sessions. In near future it may be possible to treat all type of Indian hairs with low cost laser (like a nitrogen laser) with reduced number of treatments with Indian made laser for Indian people.

8.3 Pityriasis versicolor

We compared the treatment of pityriasis versicolor by using UV lamp and UV nitrogen laser. The same number of photons as the UVB lamp were used for exposure by using UV nitrogen laser. It was a unique experiment first time performed by our group. It was observed that with the application of laser in treating pityriasis versicolor, the drug doses were reduced to nearly 50 % also the nitrogen laser sessions were reduced by approximately 50 % hence the process is doubly advantageous. In treating pityriasis versicolor the dermatologists rarely use laser.

We therefore propose that if the low cost laser like UV nitrogen laser is used for the treatment of pityriasis versicolor, the relapse rate will be reduced significantly. Treatment time reduces by 50 % and the patient gets early and permanent relief from pityriasis versicolor. In coming few years the atmospheric temperature and hence humidity is likely to be increased and hence
the superficial fungal infections like pityriasis versicolor may be prevailing on endemic level. In this situation pulsed nitrogen laser may be the best choice for the treatment of pityriasis versicolor.

8.4 Psoriasis

Psoriasis is a T-cell mediated autoimmune disease. We used pulsed nitrogen laser first time for the treatment of psoriasis. Excimer laser at 308 nm wavelength is the commercially available laser along with pulsed dye laser at 575 nm wavelength.

The disadvantage using excimer laser (belongs to UVB) which produce acute side effects like erythema, pruritus, etching etc. All these side effects were removed by using pulsed UV nitrogen laser belongs to UVA-2 range\textsuperscript{9,10} (UVA-2 has 25% predominance in UV range). (Fig. 2.10, chapter 2, page 67) UV nitrogen laser is benign as far as skin carcinoma is concerned. It is 10 times low cost treatment modality as compared to pulsed excimer laser\textsuperscript{11} ($4000 as compared to 40,000 $). Treatment may be prolonged by a week or two, it brings satisfactory results.\textsuperscript{12} Further research however is necessary to reduce the number of sessions.

Immune altering biological therapy in psoriasis is costly treatment. Each injections dose costs about 1 to 1.5 lakhs. The additional drug such as Infliximab is also very costly. It needs about Rs. 2 lakh per person per dose. Further research is however necessary to reduce the cost of such drug and other drugs.
The use of PUVA and UVB in treatment of psoriasis inhibits cell division and proliferation of cell division is checked and decreased considerably reducing the psoriatic plaques.\textsuperscript{13} If the pulse width is reduced further and beam width is used in nm or pico meter then the nitrogen laser can be effectively and efficiently used.\textsuperscript{14} The nano second or pico second pulse duration treatment becomes effective and efficient. Absorption of photo-chemotherapy can be delayed and reduced by using fat rich meal and diet.

8.5 Vitiligo

The treatment of vitiligo was the first known medicinal application of natural light and psoralens in India. It has been observed that the injury at the boundary of vitiliginous patch and normal skin can bring about pigmentation.\textsuperscript{15} Though the pigmentation of the glabrous skin asides the normal skin is difficult but by creating injury artificially pigmentation can be brought in vitiliginous patch. Micro-dermabrader works on the same principle. Curcumin, the color pigmentory constituents of turmeric is found as anti-pigmentary agent in vitiligo. Curcumin (difurourocyol methane) a major yellow pigment of turmeric, which is important ingredient as a spice, wound healing and skin lightening in India, if prevented in a diet-preparation for nearly six months, improves vitiligo.\textsuperscript{16} Turmeric is the major curry ingredient of Indian spices. There is further need to find other Indian food ingredients like turmeric which restricts pigmentation in the vitiliginous skin.\textsuperscript{17}
UV nitrogen laser slowly but definitely brings the pigmentation in vitiliginous patch,\textsuperscript{18,19} however further improvement in the pulse duration, spot size and glabrous skin treatment is necessary to bring about miraculous results in treating physiologically, psycho-socially and cosmetically damaging pigmentary skin disease called vitiligo.\textsuperscript{20}

After experimenting on segmental vitiligo we now concentrate on vitiligo vulgaris. Recently we have started studying few patients of vitiligo vulgaris whose body area is more than 50 % depigmented. We are studying the rate of transport of melanin in case of all types of vitiligo.\textsuperscript{21}

\textbf{8.5.1 Narrow band UVB micro phototherapy for the treatment of vitiligo}

One of the side-effects of phototherapy or photo-chemotherapy is the uneven re-pigmentation of the treatment areas. One of the new therapies which overcomes this side effects is narrow band (NB) UVB micro-phototherapy that delivers NB-UVB directly to the lesions using different conical hoods, through special phototherapy devices. This therapy is particularly applicable for treatment of less than 30 % skin surface involved for treatment of segmental type vitiligo.

Super narrow band 308 nm excimer laser carries the same advantages as micro-phototherapy but because of its small spot size its use can be limited only to focal patches of vitiligo. Pulsed UV nitrogen laser can remove both these disadvantages. UVB micro-phototherapy if combines with laser may give miraculous results. As the UV radiation can be directly delivered to the lesions,
it has greater advantages than other modalities of phototherapy. Enhanced efficacy have been found with combined use of NB-UVB phototherapy and bath PUVA therapy.

8.6 Rate of transport of melanin in vitiligo

We studied number of patients of vitiligo vulgaris having more than 50% body surface area depigmented. We plotted few graphs to study the rate of transport of melanin in this type of vitiligo vulgaris. In all these graphs we found that length to area ratio (l/A) for vitiligo patch decreases as the height of patch increases. \(^{22}\)

8.7 Future planning

We are planning to work on tattoo removal by using pulsed CO\(_2\) laser in our laboratory. We are thus planning to cure inoculation leprosy which prevails in some tribal regions of Melghat, Gugamal and Chikhaldara of Amravati district (M.S.).

The dreadful skin disease like leprosy may be detected in initial stages with the help of laser induced fluorescence (LIF). This technique may help in avoiding direct contact with the diseased portion, expected infection and may help in avoiding consequence of the deformities, disfigurement and socio-psychological trauma.

Most of the dermatologists show their inability and annoyance to cure the diseases like psoriasis, vitiligo etc. These diseases can be treated and recovered using new technology like laser technology. The efficiency of the
method may be improved by using the photosensitive drugs externally and internally. Laser beam destroys micro-organisms like bacteria and fungus. If the patches on the skin affected by the micro-organisms are exposed to intense laser radiations, the micro-organisms in the patches or lesions would be destroyed. Thus the number of micro-organisms in the patches will be reduced to considerably low value. Sometimes the value may be less than threshold value of the infection and skin disease may be cured. In some cases the number of micro-organisms may be reduced but it may not decrease below certain level. In such a situation some other technique may be utilized for the destruction of remaining micro-organisms.

8.7.1 Recent breakthrough

According to the recent research in USA and UK in the laser induced cosmetic surgery, facial resurfacing of the patient can be completely wrinkle-free treatment performed in just 7 minutes. This new technology is called Asthera PPX. (Times of India 19-10-2006)

This new technology is used for skin resurfacing, blepharophasty, treating vascular lesion, xanthelasma etc. Using this new technique a patient can look younger than his physiological age. The treatment rate is very fast and free of pain, erythema, pruritus and etching. Facial skin can look smooth, glowy and lustrous.
8.8 Laser in an Indian setup

At present, laser treatment is expensive and hence only few patients can afford it. It is also difficult for one individual to setup and maintain a laser system. However, now many dermatologists have ventured into setting up laser centers with facilities for one or two types of laser. Laser hair removal in particular has become very popular both amongst patients and dermatologists. There are few centers with one or two types of laser and very few mega-centers which have all types of lasers under one roof. Because a single type of laser system cannot treat all kinds of cases, more than one type would be required in treating unwanted hairs, vascular lesions, pigmented lesions, tumors, malignancies etc. To have more than one or two laser systems, it will require a group of individuals to invest. Till then, lasers could be hired or laser companies could be involved in setting up centers on sharing basis. Also, training centers should be setup so that more and more dermatologists can undergo training and offer this treatment facility to patients.

Indian skin type IV to VI is on darker side hence there is need to standardize the procedures to avoid post operative pigmentary complications. Proper patient selection and judicious use of laser technology along with various pre and post operative cream programmes (hydroquinone, tretinoin, sunscreens etc) will yield good cosmetic results.

The medical or dermatological applications of lasers are rapidly expanding. The laser system modality offers a number of advantages, however its high cost of setup and the fact that more than one laser system is required, restrict its usage. With ongoing research in new laser system development, it
may be possible in the near future to treat most of the conditions with a single or fewer laser systems.

### 8.9 Lasers in dermatology and photo-medicine: past, present, and future

Dermatology and photo-medicine are closely allied. The skin is the primary barrier to light and a principal target of non-ionizing electromagnetic radiation in the ultraviolet, visible, and infrared range. Research on the cutaneous biology and the therapeutic role of laser radiation on skin has improved our understanding of the effects of lasers on various biologic systems and has led to the diagnostic and therapeutic use of lasers in medical and surgical disciplines outside the dermatology. When electromagnetic radiation is absorbed by biologic molecules it can result in photochemical reactions. These reactions initiate biochemical and biologic responses to light. The energy of photons in the ultra violet (UV 200 to 400 nm wavelength) and visible wavelengths can cause electronic excitation of specific chromophore molecules, leading to specific chemical reactions.

Photo-medicine is defined as the application of the principles of photobiology to the diagnosis, treatment, and understanding of health and disease. The study, diagnosis, treatment, prevention of photo-dermatoses, skin cancer and chronic actinic changes of skin are important topics within photo-medicine. Photo-medicine has also developed techniques for the use of non-ionizing electromagnetic radiations with and without the addition of photoactive drugs, to treat disease.

Ultraviolet radiations could kill germs, make strong bones, and treat diseases. Rosy cheeks, erythema, or tan from sun exposure came to signify glowing health.
From therapeutic standpoint physiological effects of UV radiations include erythema production, pigmentation of the skin, bactericidal effects, various effects on metabolism. In addition to that UV radiations can cause degenerative and neoplastic changes in the skin, retinal change, cataract, modification of immunological system of the skin. (In clinical practise UV radiation dose is measured in minimum erythema dose [M.E.D.])

Ultraviolet radiations and visible light are now used to prevent brain damage in selected newborn infants with hyper-bilirubinemia. Ultraviolet radiations, with and without photosensitizing chemicals, is used to treat certain benign and malignant skin diseases, including psoriasis, atopic dermatitis, lichen planus, pityriasis versicolor, mycosis fungoides and vitiligo among others. Lasers are used to prevent certain forms of blindness and to perform bloodless surgery.

The introduction of PUVA or oral psoralen photo-chemotherapy of psoriasis in the early 1970s (first use in 1974) provided a new breakthrough for basic and applied research and a stimulus to develop sophisticated UV irradiators, including high intensity sources of UVB.

Another important example of photo-chemotherapy is the use of photosensitizers and visible light in the treatment of cancer. This form of therapy, also called photodynamic therapy (PDT), depends on selective localization of photosensitizers in malignant tissue and subsequent exposure to light of appropriate dosimetric parameters.
References


