Lasers in Dermatology

Essay Submitted for the Partial Fulfilment of the Master Degree in Dermatology and Venereology

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1994

بسم الله الرحمن الرحيم

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To my family

Acknowledgements

I would like to express my profound gratitude and sincere appreciation to my Prof. Dr. **Zenab El Gothamy**, Professor of Dermatology and Venereology, Faculty of Medicine, Ain-Shams University, from whom I learned a lot both practically and scientifically, and for her great and continuous support, encouragement and warm advice.

I would also like to thank Dr. **Maha Abou El Magd** Lecturer of Dermatology and Venereology, Faculty of Medicine, Ain-Shams University, for her help, advice, and support.

Finally, I would also like to thank the staff members at the Department of Dermatology and Venereology, my colleagues, friends and my family for their kind sympathy and understanding during the accomplishment of this work.

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INTRODUCTION

Introduction

Laser is a device that generates or amplifies visible light waves. In fact, the word *laser* is derived from the principle of the device itself: Light Amplification by Stimulated Emission of Radiation. The laser can generate a beam of light that is coherent, highly directional, and highly intense. These properties have been used for a variety of remarkable applications in medicine as well as many other spheres of our lives [(1)].

Lasers have been used in dermatology for over twenty years. In the early years, clinicians had only a few laser systems available to them [(2)]. However, recently, there has been a great increase in the understanding of laser-tissue interaction which has resulted in the development of numerous new-generation laser systems that take full advantage of the unique properties of laser light to achieve very specific and confined effects in tissue while minimizing collateral damage [(3)].

The introduction of pulsed tunable dye lasers has considerably improved the treatment of vascular lesions, particularly port-wine stain malformations in children. Other laser systems available for treatment of vascular lesions include a wide range of the continuous-wave and quasi-continuous-wave lasers. Their use in conjunction with automated delivery systems has improved results whilst reducing adverse effects. Increasing interest in treatment of pigmented lesions and tattoos has led to investigation of a range of high power short-pulse lasers, and results are promising. However, further work is needed in all areas to determine which lesions respond best to each laser system, and which treatment techniques are optimal (2).

The properties of the laser have been used for a variety of remarkable applications. Because of its coherence, the beam can be adjusted to an accuracy that is within one third of an inch per mile. Precise measurements of distance are then obtained by reflecting the laser beam from a distant point and determining the time required for the light to make the round trip. This method was used by scientists to measure the distance between the earth and the moon, with the help of a reflecting device placed on the moon by Apollo astronauts (1).

Lasers have been used to obtain extremely accurate alignment for such engineering projects as pipelines. In military use, a laser-guided bombing system has proved highly accurate; the target is illuminated by the laser beam and the bomb is then guided by the beam's reflection from the target (1).

In manufacturing industries, the laser can perform special tasks with speed and accuracy. Cutting and drilling of ultra hard metals, such as tungsten, can be done much more easily and quickly with a laser than with standard tools. Certain welding operations are ideal for lasers, since the quick flash of heat binds materials together instantly and firmly [1].

Another important use of the laser's unique qualities is in **"holography"**, a method of producing three-dimensional images [1]. Specially focused laser beams can be used to produce heat many times greater than that of the sun. The heat is capable of burning a hole in a diamond in less than one second. In the field of medicine, a laser serves as a surgical knife for delicate operations on the eye, brain, and other organs where conventional operating methods are often difficult [4].

REVIEW OF THE LITERATURE

BASIC LASER PHYSICS

Review of the Literature

Basic Laser Physics

Until the twentieth century, the sun was the main source of human skin exposure to energy within the photobiologic action spectrum. More recently, artificial devices capable of mimicking the emission of some or all of the solar spectrum have been introduced, compounding the opportunities and risks of ultraviolet radiation exposure [5].

The sun emits a wide variety of electromagnetic radiation (**EMR**) (Table 1). All **EMR** travels at the same speed (in a vacuum) - the "**speed of light**". Since the speed of a wave equals the product of its wavelength multiplied by its frequency, and since the speed of all types of EMR is the same, the wavelength and frequency of all EMR are inversely related. The larger (or longer) the wavelength, the lower the frequency. Thus, light may be referred to in terms of its frequency or its wavelength: the higher the frequency (or the shorter the wavelength), the "*blue-er*" the colour. The amount of energy in light (or any EMR) is directly related to its frequency, blue light having more energy than red light [6].

Table 1 : The Electromagnetic Spectrum [7].

Type of Radiation	Wavelength
Cosmic	0.00001 nm
X-Ray	0.1 nm
Ultraviolet	10 nm to 100 nm
Visible	400 nm to 700 nm
↳ Violet	430 nm
↳ Blue	490 nm
↳ Green	530 nm
↳ Yellow	577 nm
↳ Orange	590 nm
↳ Red	630 nm
Infrared	770 nm to 12,000 nm
↳ Near	1,000 nm
↳ Mid	10,000 nm
↳ Far	12,000 nm
Microwave	1.0 cm
Television and FM radio	100 cm
AM radio	10,000 cm

White light **(which is a mixture of all the colours)** is composed of EMR of varying wavelengths traveling in all directions (Figure 1). Light of one colour is said to be monochromatic and is composed of only one wavelength (or of a small range of wavelengths). However, the light waves are not **"in phase"**. Although the light waves may be of the same wavelength, each wave will not be at its peak at the same time [8] (Figure 2).

Figure 1 : White light is composed of all wavelengths, traveling in all directions [6].

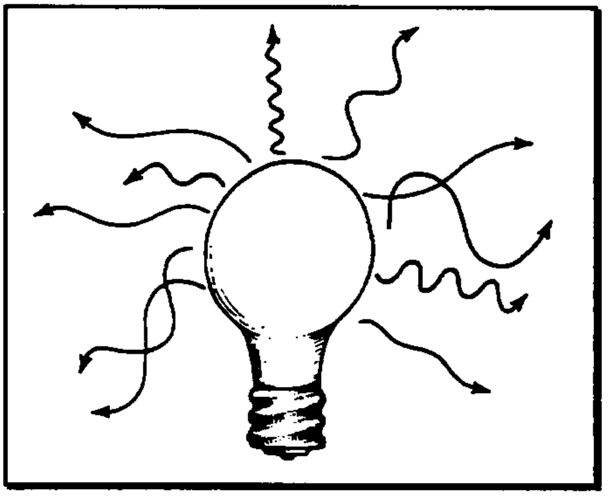

Figure 2 : Ordinary monochromatic light : waves are not in phase and not traveling in exactly the same direction [6].