Intense Pulsed Light and Laser Systems - A Brief Comparison

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Abstract

Lasers have been used for a number of years for applications such as hair removal and vascular lesion removal. In recent years, the use of lasers has been somewhat superseded by the introduction of Intense Pulsed Light (IPL) systems such as the Lumina (Lynton Lasers Ltd, Holmes Chapel, Cheshire, United Kingdom). This paper aims to outline the advantages and disadvantages of both types of system and give an unbiased view of the best system for different applications.

Introduction

The use of intense pulsed light (IPL) and laser systems for hair removal has been well established for a number of years[1]. It is an effective alternative to traditional methods such as electrolysis and waxing, allowing long-term, and often permanent, hair removal. Lasers have been used for a number of years to treat vascular lesions such as port wine stains, rosacea and thread veins, and although excellent results can be obtained, patients are often dissatisfied with the extent of side effects such as pronounced purpura (bruising) and pigmentary changes.

The efficacy of both technologies for removal of unwanted hair is without question, and it is certain that both systems can be used for treatment of certain types of vascular lesion. However, patients may have very different skin and hair colours and there are many types of vascular lesion. Each condition will be best treated with specific wavelengths and parameters, and it is the aim of this study to summarise and discuss the pros and cons of both laser and IPL systems.

IPL and Laser Comparison

The main differences between laser and IPL sources are down to the very different technologies implemented in each system. Lasers are light sources which emit monochromatic (single wavelength) light. The light produced by a laser is coherent (all the light is in the same phase and of the same wavelength) and collimated. This means that laser light shows very small divergence and the spot size will remain more or less constant even over very long distances. IPL systems are generally flashlamps which produce light when a small electric current is passed through a gas. The light produced in this way is not coherent, and consists of many different wavelengths. This is known as white light. The light is emitted in all different directions and therefore is not collimated and will spread out over a given area (in the way that a lightbulb will light a whole room as opposed to a laser pointer, that will just produce a spot of light).

These differences in the way in which the light is produced have a number of consequences. Lasers have found many applications as a result of the production of coherent, collimated light, such as their use in CD players, and because of the small spot sizes, large energies can easily be achieved. However, there have unfortunately been many reported incidences of biological damage due to lasers. The small spot sizes and high energies mean that burning of the skin can often occur, but more commonly, every year people have their vision impaired or are even blinded by lasers. The main reason for this is the non-divergence of laser beams. This means that if the eye is unprotected and a beam enters the eye, even from a laser a large distance away, the entirety of the laser spot and the total energy of the system is incident on the retina. IPL systems on the other hand emit divergent light. This means that in the event of the light being incident on an unprotected eye, it should have spread out to such an extent that only a very small proportion of the total light energy of the system will reach the retina.

Another advantage of IPL is that the area over which the light is emitted is considerably larger than that of a laser spot. As an example, the Lumina utilises a number of different size light guides, the largest of which is 50mm by 10mm (total area 5cm^2). Compare this to a typical laser spot size of 5mm, which gives an area of 0.2cm^2, 25 times smaller than the IPL, and it's clear to see

that larger areas can be treated with an IPL system considerably faster and with greater ease than with a laser.

IPL systems have a much simpler design than lasers. This means that no complicated alignment procedures and specialist optics are present. Not only does this reduce the cost of the machine, but also greatly reduces the need for regular maintenance and it minimises the chance of a malfunction in the machine. The lower cost of running and less time spent per treatment can then be passed on to your patients.

The monochromatic nature of laser light means that if a chromophore has a very sharp absorption peak at a given wavelength, then a laser emitting light at that wavelength will target the chromophore extremely effectively. For example, in tattoo removal, we need a lightsource that will emit light of the correct wavelength to target the absorption peak of the tattoo pigment, and excellent results are obtained with lasers. At present, IPL systems can not be used for tattoo removal because the pulses of light cannot be made short enough to cause fragmentation of the pigment. However, for applications such as hair removal, very short pulses are not required, and in fact are not clinically effective. Pulses have to be of a long enough time period (milliseconds) to effectively heat the whole hair follicle.

The broadband nature of IPL light also has advantages over monochromatic laser light in some applications. The absorption spectra of melanin and haemoglobin are shown in figure 1.

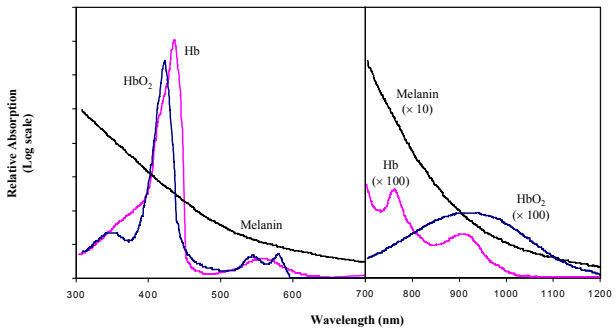
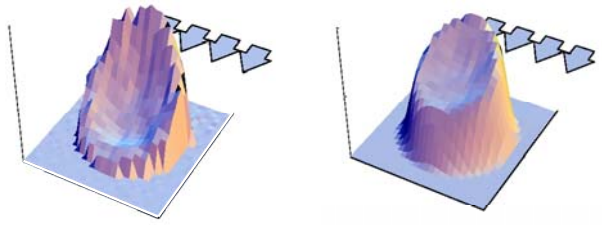


Figure 1: Relative absorption of melanin and blood (haemoglobin and oxy-haemoglobin). Adapted from Anderson and Parrish [2].

It is clear to see that none of the spectra consist of single, sharp absorption peaks. In fact, the spectra are relatively broad. This means that absorption occurs at many different wavelengths, most of which can be targeted with IPL. In the case of vascular lesion removal, for which haemoglobin is the target chromophore, a Monte Carlo numerical analysis[3] has been performed, which shows that more uniform heating of the vessel is achieved with an IPL source than a 577nm laser. This is because light of this wavelength is absorbed by blood very efficiently. The result of this is that most of the light is absorbed before getting a chance to penetrate through to the rest of blood vessel. IPL can penetrate to a deeper level, resulting in more uniform heating which means that vessel rupture, and associated purpura, is much less likely with treatments using IPL systems than with lasers.



(a) *(b)*

Fig. 1: Monte Carlo numerical simulation results displaying absorption in blood vessel for (a) 577nm and (b) broadband light.

Conclusion

This study presents a brief comparison between lasers and Intense Pulse Light systems. It is certainly true that there exist some conditions for which lasers are the preferred choice, such as tattoo removal. However, for many other applications such as hair removal and vascular lesion treatment, IPL systems may offer advantages over laser systems including improved safety features, increased reliability and equal, if not superior, clinical results.

References

[1] R. A. Weiss, M. A. Weiss, S. Marwaha, A. C. Harrington, "Hair Removal With a Non-Coherent Filtered Flashlamp Intense Pulsed Light Source". Lasers in Surgery and Medicine **24**: 128 – 132 (1999).

[2] R. Anderson, J. A. Parrish, "Microvasculature can be Selectively Damaged using Dye Lasers: A Basic Theory and Experimental Evidence in Human Skin". Lasers in Surgery and Medicine **1**: 263 – 276 (1981)

[3] J. M. Hammersley and D. C. Handscomb, 1964, *Monte Carlo Methods*, John Wiley & Sons, New York