AN INTRODUCTION TO THE LASER/IPL REMOVAL OF

Blood Vessels

DERMA-LASE
LASER & IPL TRAINING

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Ed. 1.2

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LASER & IPL TRAINING

Introduction

Treating blood vessels with laser technology has been around since the mid 1980s. Mike was involved in the original research in the UK, in Canniesburn Plastic Surgery and Burns Unit, Glasgow, Scotland.

In those days we used a pulsed dye laser from Candela (one of the first they ever made!) with a 577nm wavelength and far too short a pulsewidth. But, we did manage to obtain some reasonable clinical results...

In 1990 Mike met Morgan Gustafsson, a Swedish doctor/engineer, who had created a strange looking ‘device’, which later would become an Intense Pulsed Light unit. Together with PA Torstensson, they developed this unit until a workable device was finished which could remove blood vessels. We did not consider removing hair with it back then!

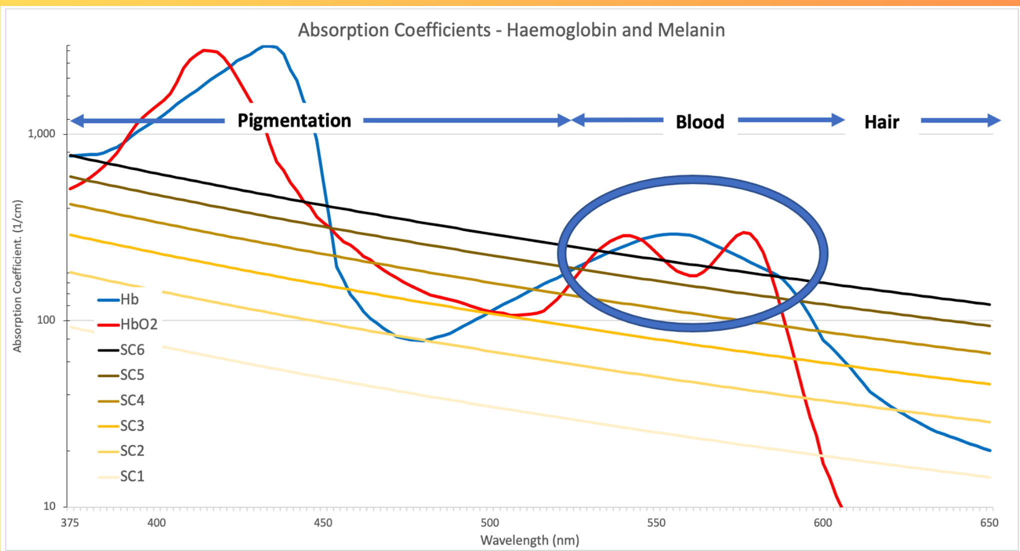
Later, new filters were designed which allowed us to apply more appropriate wavelengths to the skin, which could destroy hair follicles. To effectively target follicles we needed to hit it with red-infrared wavelengths - between 600 and 1200nm, with sufficient fluence.

Nowadays, IPLs are used across the planet to remove hair, vessels, pigmentation and for skin rejuvenation, very successfully.

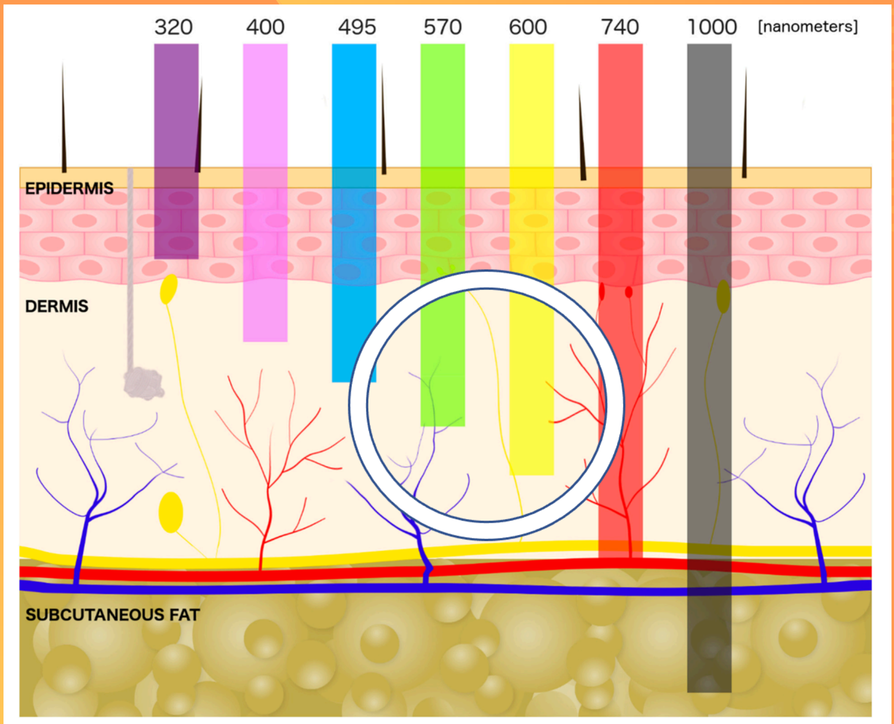
So, how does this process work?

When treating blood vessels with light energy, we are trying to electively heat up the blood, without heating the surrounding tissues (dermis) too much.

To do this, we select wavelengths which are known to be strongly absorbed by the haemoglobins.



The above graphs show how oxy- and deoxygenated haemoglobin absorb from 375nm up to 650nm. The blue oval shows where these absorption curves are at their greatest (away from the harmful blue end) - between around 500 and 600nm. So, we deliver light energy in this range, knowing that it will be preferentially absorbed by the blood. Some of this energy will also be absorbed in the melanin (the ‘SC’ curves), but as long as more is absorbed in the blood, we will achieve our goal. Note that this becomes more difficult as the skin colour darkens.



With IPL systems we typically use the green and yellow wavelengths to target the blood vessels. KTP lasers use the 532nm line, while long-pulsed Nd:YAG lasers use the fundamental 1064nm wavelength. Pulsed dye lasers may use between 585 and 595nm, typically, for this purpose.

Most of the wavelengths will reach a similar depth in the skin, which limits their success. The Nd:YAG 1064nm can penetrate deeper into the skin (due to more forward scattering) and so is useful for deeper vessels.

As long as sufficient fluence (concentration of energy) is applied in a suitable pulsewidth (usually milliseconds) then those vessels can be successfully coagulated.

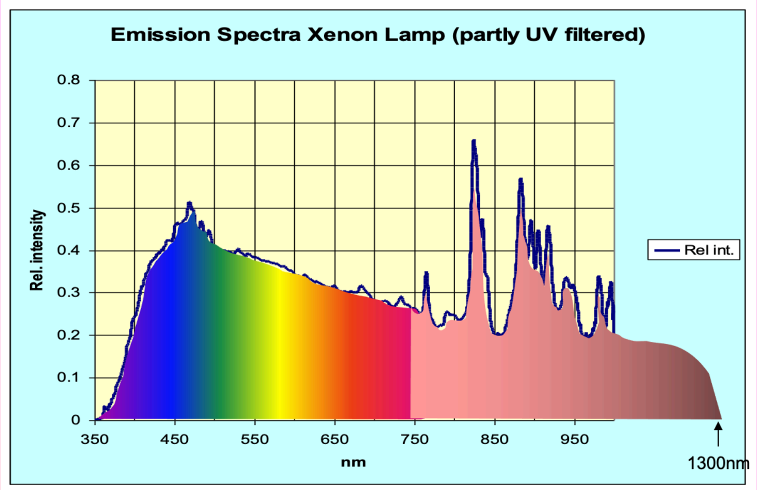
Technologies

A number of technologies are available today for the treatment of blood vessels. These include pulsed dye lasers, KTP lasers, long-pulsed Nd:YAG lasers and IPLs. There are other devices which can do the same job, without using light energy. We will not discuss those here.

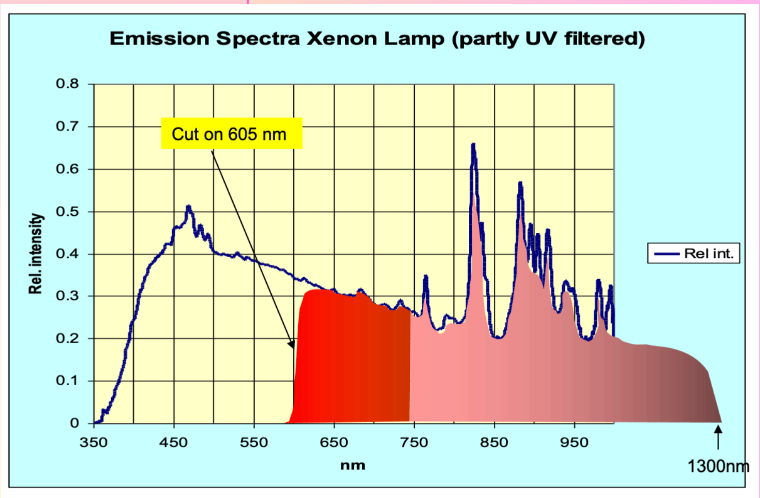
This port wine stain (PWS) was treated over four sessions with an IPL unit.

The result is a significant lightening of the stain, but more sessions are required for complete removal.

IPL Systems

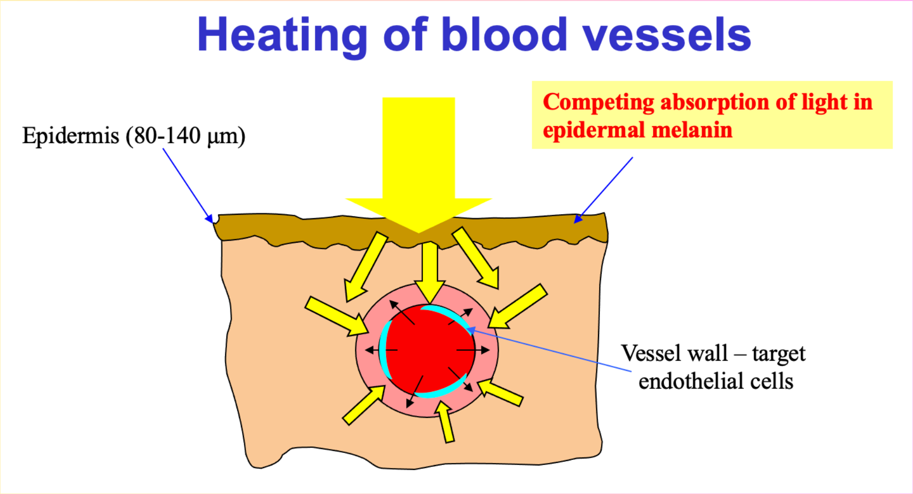


The above shows the light energy output from a standard Xenon flash lamp, typically found in IPL systems.



But, often we don't require all of the light energy. So, we put filters in the handpiece to block some of the wavelengths - in this case, a 605 nm filter stops all the (blue, green and yellow) light below 605 nm from reaching the skin surface.

By selecting the wavelengths we want, we can enhance the absorption of some of that energy by the haemoglobins in the blood vessels - resulting in heating of those vessels.



When the blood heats up, some of the thermal energy diffuses out to the walls of the blood vessel. Located there are **endothelial cells**, which dictate the vessel size. In enlarged vessels, those cells have become ‘disturbed in some way, resulting in larger-than-normal vessels.

If we apply the correct fluence along with the correct pulsewidth, we can induce a thermal coagulation of the endothelial cells and shut down those vessels. They will not come back, but new enlarged vessels can always appear at any time in the future.

LP Nd:YAG Lasers

Long-pulsed Nd:YAG lasers emit a wavelength of 1064nm. This wavelength is not particularly strongly absorbed by the heamoglobins, yet, this technology can be useful when treating vessels.

So, how do these lasers work?

Unlike IPL systems, long-pulsed Nd:YAG lasers use very high fluences, typically around 100 to 400 J/cm^2 in a range of pulsewidths from around 10 to 200ms. However, to achieve such high fluences they usually require relatively small spot diameter of around 1 to 10mm (small relative to IPLs).

Clinical studies suggest that this modality is more efficient in destroying larger vessels, compared with IPL systems.

The longer, infra-red wavelength (1064nm) is definitely more useful when targetting deeper vessels.

A Korean long-pulsed Nd:YAG laser

Pulsed Dye Lasers

Pulsed dye lasers were developed after two American scientists, Anderson and Parrish, came up with the idea of Selective Phtotothermolysis in the early 1980s. Their concept was to selectively heat only the target tissue - haemoglobin, using the correct amount of fluence in the correct pulsewidth.

They approached a laser engineer - Horace Furumoto - who designed and built them the world's first pulsed dye laser for this purpose (in his garage in Boston!)

They applied this prototype laser to port wine stains in the Wellman Labs in Boston. We started a similar project Glasgow in 1985.

Both groups found that it was possible to successfully remove some of the enlarged vessels. However, some were more difficult, and so longer wavelengths and pulsewidths were later tested - 585 and 595nm in 0.4 ms pulses. In addition, longer pulsewidths were also tested and found to be more useful.

One downside of this modality is the occurrence of purpura - this is due to blood leaking form damaged vessels into the surrounding dermis.

The Candela Vbeam pulsed dye laser

KTP Lasers

KTP lasers output a wavelength of 532nm whcih is strongly absorbed by the haemoglobins. A typcial KTP laser might deliver up to around 20 J/cm^2 in a 5-30 ms pulsewidth range into spot diameters between 1 and 12 mm.

One particlar problem with the KTP wavelength is that it is also strongly absorbed by melanin (see the graphs on page 3). Hence, it can induce more hyper- or hypopigmentation than other systems, partculaly in darker skinned people.

A typical KTP laser

An advantage of this modality over pulsed dye lasers (as with IPLs and long-pulsed Nd:YAG lasers) is that purpura is not produced during the treatment, particularly with the longer pulsewidths. This is due to the blood coagulating inside the vessels. The shorter pulsewidth of the dye laser induces a much more aggressive ‘explosive’ reaction in the blood, causing the vessel walls to rupture.

KTP lasers a routinely used to treat thread veins, spider veins, PWS and ‘redness’.

Blood Vessels

Thread veins, or telangiectasias, are typically found on the face, around the nose.

These are easily treated using laser/IPL light energy.

The above vessels were treated with an IPL device using a 530 nm filter and a fluence of 35 J/cm^2, in a pulsewidth of 30 ms. The result (right) was instant.

These vessels are relatively easy to remove, using light energy. A recent development in the technology allows us to use relatively small spot sizes to ensure that only the target vessels are heated, without damaging the surrounding skin.

These small telangiectasia were removed over two sessions with an IPL unit. A fluence of 30 J/cm^2 in a pulsewidth of 25 ms was applied.

Two sessions were required, although one could have completed this treatment. However, once erythema starts to appear, it can be difficult seeing these small vessels.

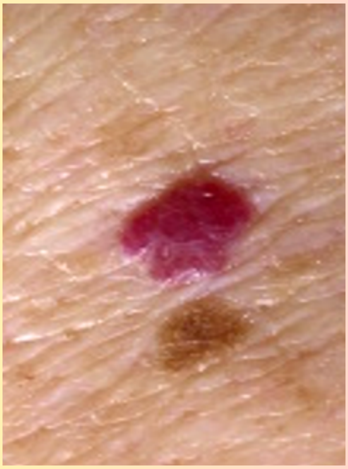
The photo here (left) shows a variety of blood vessels of different sizes, colours and depths. This makes it a little trickier to try them.

Mike used an IPL with a 530nm filter at a fluence of 30 J/cm^2 in a pulsewidth of 25ms.

The immediate results can be seen below.

Clearly, some of the vessels have shrunk whilst others have been unaffected. This is unsurprising - the 'blue' vessels are too deep and too large for an IPL. However, Mike realised that he should have used a higher fluence to properly shut down the smaller vessels.

Blood Vessels



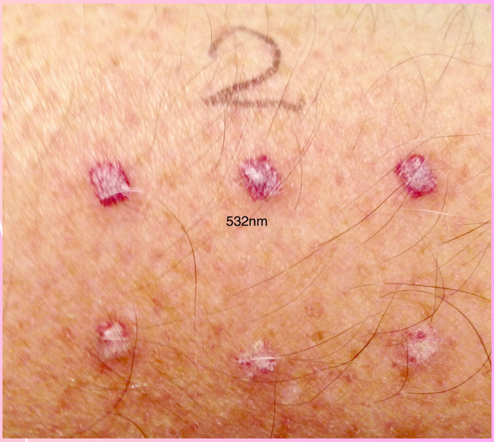
This picture (left) shows a small vascular lesion alongside a small pigmentation mark. Mike treated them with an IPL at 40 J/cm^2 and a 480nm filter in a 30 ms pulsewidth. Only one shot was needed in each session.

On the right we can see some red ‘track lines’ caused by the metal cooling plates on the IPL handpiece tip. These are noting to be concerned about - they disappear within a day or two.

Here we see the final result after four sessions spaced out over around 12 months. The blood spot has almost completely gone while the pigmentation still remains, albeit very slightly.

These things are easily removed with lasers and IPLs.

Blood Vessels



It is important to use the correct technology when treating vessels. We want to induce a 'photothermal' reaction in the vessel walls. These pictures shows what can happen when a Q-switch Nd:YAG laser is applied to the skin, with the 532nm wavelength. This wavelength is strongly absorbed in blood and can create short-term capillary damage, as we see here.

Final Comments

Some people say that IPLs cannot effectively treat blood vessels (or hair!) Those people don't know what they're talking about!! In the simplest terms lasers and IPLs merely deliver light energy into the skin. Once the light enters the epidermis, its source becomes entirely irrelevant. It really doesn't matter if it's monochromatic, coherent and/or minimally divergent...

As long as sufficient energy is delivered in a suitable pulsewidth, the heating effects on the targets will be very similar.

We can see, from the above, that a wide range of fluences, pulsewidths, wavelengths and spot sizes are used to effectively tackles all sorts of blood vessel problems. In essence, these are among the easiest skin problems to treat, but we should not think that they are all that easy. Many vessels may be too large and/or too deep for the light energy to successfully coagulate them. In such cases, other techniques need to be employed.

If you find that your treatments are not so successful, go back to the drawing board and ask yourself - am I applying the correct settings? In most cases, our experience is that the answer is that the fluence is too low!!

Mike Murphy has been investigating laser-tissue processes and treatments since 1986. He has published many peer-reviewed papers, articles and books on various topics including the removal of hair, tattoos, blood vessels, pigmentation using lasers and IPL systems.

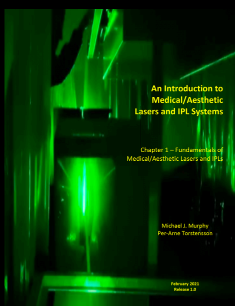
He continues to research all of these areas and still presents his work at international medical laser conferences.

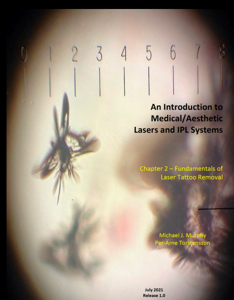
He has published three books on this subject:

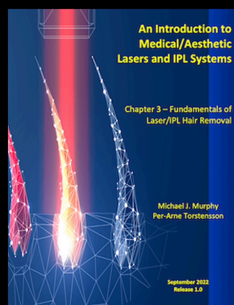
- An Introduction to Medical/Aesthetic Lasers and IPL Systems
- An Introduction to Laser Tattoo Removal
- An Introduction to Laser/IPL Hair Removal

You can find his blog at 'MikeMurphyBlog.com'

You can download this booklet as a pdf from 'Scribblings.info'







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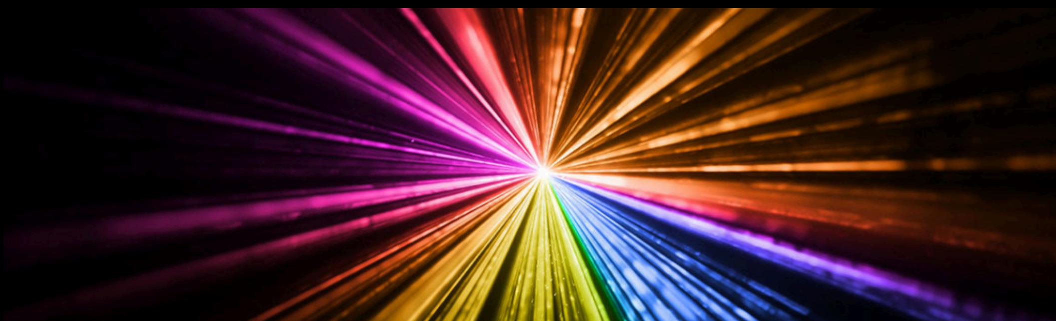

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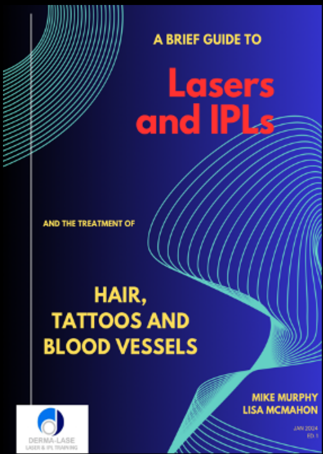

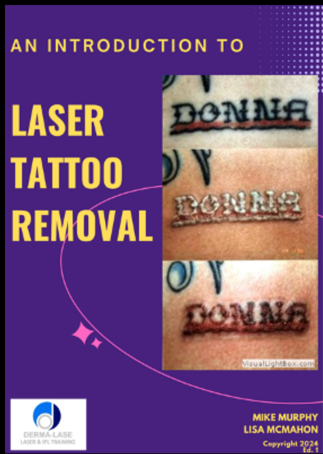

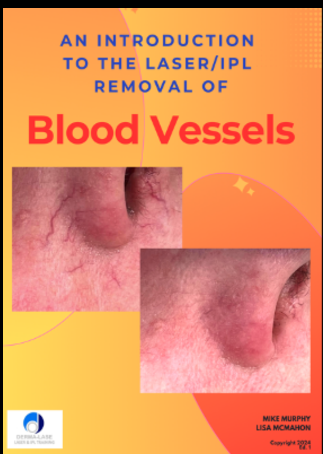

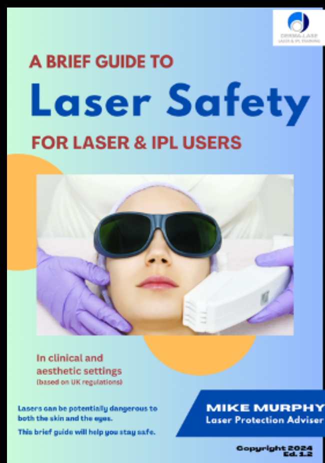

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