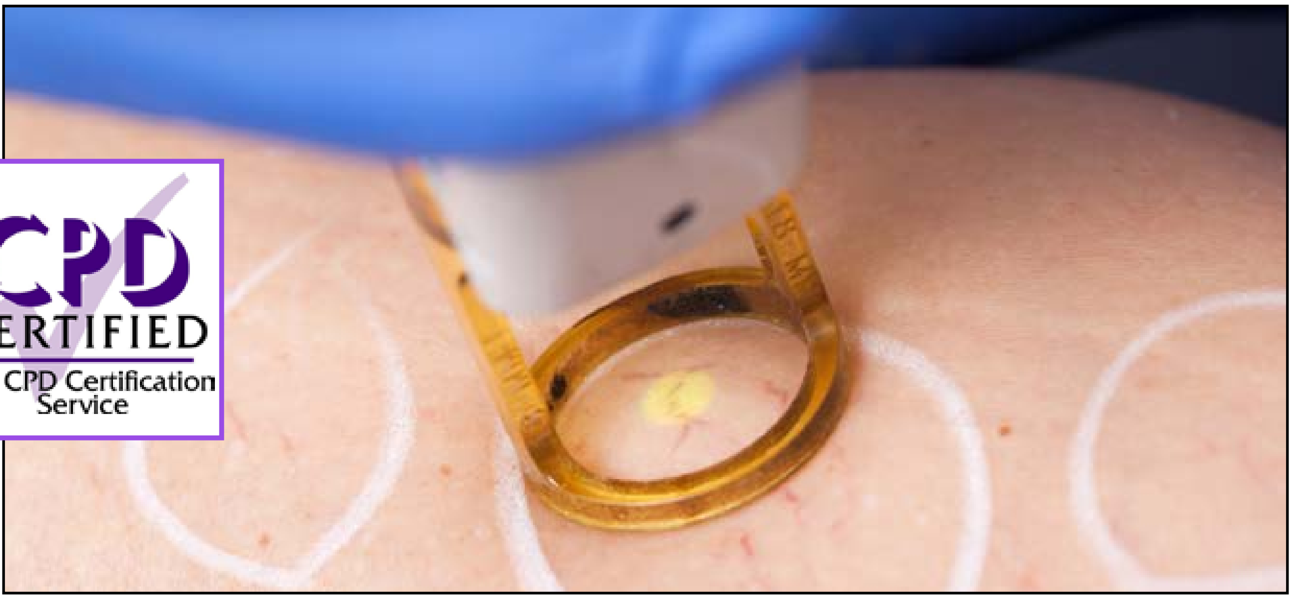

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HAVE A BRAINWAVE ABOUT 'VEIN' WAVES!

Dr Asif Hussein and Dr Sajjad Rajpar unravel the laser options when it comes to treating veins and vascular lesions

It can be difficult for the inexperienced practitioner to select a laser device for vascular lesions. We will discuss the core principles that determine the choice of laser and share our personal experience in using lasers, for a decade, for numerous vascular lesions for various indications.

The core principles discussed are:

1. Selecting the correct wavelength
2. Selecting the correct pulse duration
3. Selecting the correct spot size

A sound understanding of laser-tissue interactions is required as this underpins clinical laser dermatology.

The target chromophore is haemoglobin in the treatment of vascular lesions. Water can also be a secondary target. Haemoglobin comes in various oxygenation states: oxyhaemoglobin (Hb02), methaemoglobin and deoxyhaemoglobin. The varying oxygenation states have subtle differences in absorption spectra.

This is an important consideration when refining the choice of laser.

Figure 1 – Hb and HbO2 absorption spectra

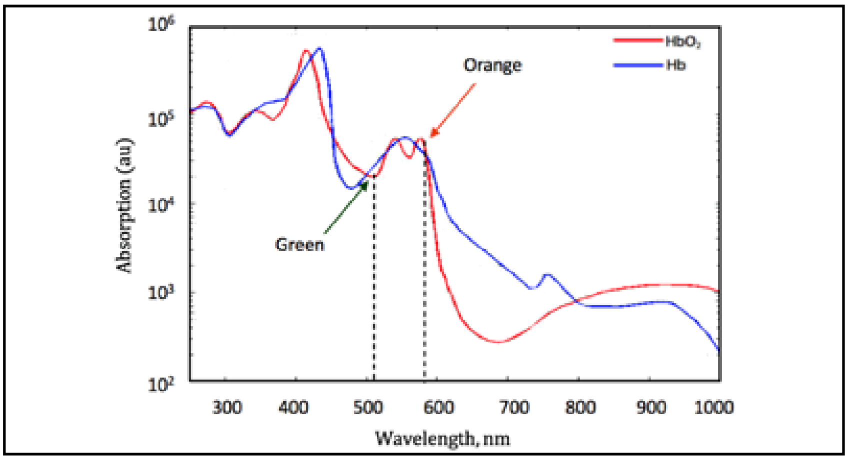
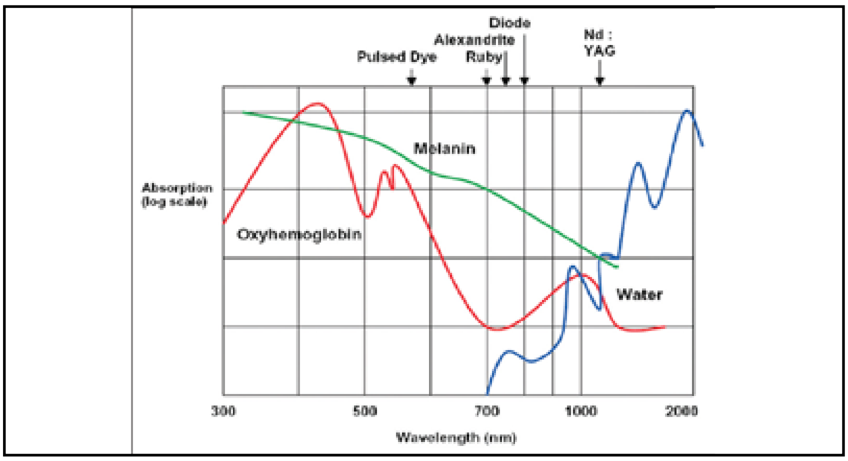


Figure 2 – Water vs Haemoglobin absorption spectra



Selecting the correct wavelength

There are numerous peaks in the Hb/ HbO2 absorption spectra. Because melanin absorption is relatively high in the 400-500nm range, lasers in this wavelength are not specific enough for Hb/Hb02 and would risk side effects such as permanent hypopigmentation.

Wavelengths in the 500-600nm (green to yellow light) range are the mainstay for vascular lesions as they are highly absorbed by Hb and relatively less well absorbed by melanin. Lasers which are suitable for vascular indications are:

- 532nm KTP (Potassium Titanyl Phosphate)
- 578nm Copper Bromide Laser
- 585-595nm PDL (Flashlamp pumped Pulsed Dye Laser)

Melanin absorption is still significant and is mitigated by cooling the epidermis and selecting an appropriate pulse duration to target vessels. Despite this, these lasers should be avoided in skin types 4-6. Risk of dyspigmentation side effects outweighs treatment benefits in Fitzpatrick 4-6.

The 800-1100nm (infrared light) range is also very useful for treatment of vascular lesions including:

- 810nm diode
- 940nm diode
- 1064nm long-pulsed Nd:YAG

Due to lower melanin absorption, these wavelengths are safer on darker skin types (FP 4-6). Importantly, water absorption increases dramatically from 800-1100nm, which can lead to bulk heating of tissue. Cooling of non-target tissue is essential when using these lasers otherwise indiscriminate thermal injury and scarring may result.

Longer wavelength lasers penetrate deeper, with the Nd:YAG being the deepest penetrating laser in human tissue. It is important to be cautious of deeper end arteries such as the alar artery when treating nasal thread veins, which may become inadvertently coagulated, leading to necrosis.

Periorbital veins must be treated with caution as well and the use of internal metal eye shields is mandatory.

Selecting the correct pulse duration

The pulse duration should approximate to the thermal relaxation time of the target in order to ensure energy is confined to the target. Targets within the skin and their relevant thermal relaxation times are listed in *Figures 3 & 4*.

Figure 3 – Thermal relaxation times

Blood vessel Diameter (telangiectasia 0-1mm)	TRT of whole structure
50 micrometres	1 millisecond
100 micrometres	5 milliseconds
0.25mm	35 milliseconds
0.5mm	135 milliseconds
1mm	540 milliseconds

Figure 4 – Competing Structures and their thermal relaxation times

Dermal Structures	TRT of whole structure
Melanosome	20-40 nanoseconds
Melanocyte	1 microsecond
Epidermis	3-10 milliseconds
Hair follicle	40-100 milliseconds

Larger vessels have greater TRTs than smaller vessels and require delivery of energy over a longer period of time. Telangiectasia (blood vessels <1mm in diameter) require pulse durations in the region of 1-600 milliseconds.

Selecting the correct spot size

Larger spot sizes permit deeper penetration of laser energy. Deeper vessels, therefore, require larger spot sizes.

Facial telangiectasia are usually superficial within the papillary or upper reticular dermis. Leg telangiectasia are usually deeper, in the order of 1mm below the skin surface.

With a 1064nm, a small spot size of 2mm would be adequate for facial telangiectasia but inadequate for deeper leg telangiectasia. A spot size of 4-6mm would be much more suitable for leg telangiectasia between 0.5-1mm in diameter.

A spot size of 4-6mm on the face, however, would be extremely dangerous as the additional penetration from the larger spot size could coagulate superficial end arteries such as the alar artery, resulting in cartilage necrosis of the nasal alae.

Treatment of vascular lesions

Facial Redness, Rosacea and Telangiectasia

Facial telangiectasia are upper dermal vessels measuring less than 1mm in diameter. They occur from:

- intrinsic ageing of the skin;
- photodamage;
- rosacea;
- poikiloderma of Civatte;
- Osler-Weber-Rendu (hereditary haemorrhagic telangiectasia);
- CREST syndrome (spider angiomas);
- generalised essential telangiectasia;
- following chronic topical steroid usage;
- following radiotherapy;
- and around a surgical scar in fair skin types.

The principal chromophore for facial telangiectasias is HbO2, and the KTP (532nm) and long pulse PDL (585-595nm) are suitable laser choices.

When treating smaller blood vessel, shorter pulse durations are required though this results in vessel wall rupture and purpura (*Figure 5*).

Purpura is an annoyance for patients as the bruising can last for several days, leading to undesirable downtime which must be discussed during consent.

Historically the PDL 585/595nm has been considered the gold standard for treating vascular lesions. Compared to the original KTP lasers, the PDL had a large enough spot size with adequate power to have utility for the greatest indications.

Historically KTP lasers had spot sizes of 2mm or less, lacked power, and

Photos courtesy of Dr A Hussein

relied on shot stacking to achieve a therapeutic result, with risk of epidermal thermal damage. These features effectively excluded KTP lasers for diffuse redness, rosacea, and larger port wine stains, despite the fact that the absorption peak for HbO2 is greater at 532nm than in the ranges of the pulsed dye laser (585 and 595nm).

Since 2007, KTP lasers have offered larger spot sizes with adequate power. This allows for effective treatment of diffuse redness (*Figure 6*) and larger port wine stains – yet their generalised use has been less widespread. The last few years has seen improved stability and reliability in these devices with solid-state technology and lithium triborate (LBO) crystals of greater stability.

Figure 7 shows a type 1 rosacea patient Dr Hussein has treated with a single session of large spot 532nm KTP. In his experience, multiple treatments with combined Nd:YAG and PDL would be required to get this level of clearance.

Long pulsed Nd:YAG lasers are effective for superficial facial telangiectasias though the risk of bulk heating makes them more appropriate for individual vessels versus diffuse microvasculature and redness.

A single-blind, split face, controlled comparison study involving 15 subjects with facial redness and telangiectasias (*DOI:10.1111/j.1524-4725.2007.33091.x*) showed that large spot 532nm KTP was superior to 595nm PDL in all treated subjects. There was more transient swelling and erythema with the KTP. In our experience, this has always proven to be true.

Our view concurs with this publication, in that the large spot KTP laser is generally more effective than the large spot 595nm PDL in treatment of rosacea, facial redness and red telangiectasia. Greater swelling and oedema arises with KTP and this is probably due to increased 532nm wavelength absorption by melanin and haemoglobin, resulting in more diffuse epidermal and superficial dermal inflammation. However, even though 532nm is more highly absorbed by epidermal melanin, the relative ratio between haemoglobin to melanin absorption is much greater with 532nm compared to 595nm. In practice, this means that the fluences required to achieve the same vascular reduction with 532nm are lower than those required with 595nm. This leads to an observable overall reduction in the risk of post-inflammatory hyperpigmentation with 532nm compared to 595nm.

Figure 8 illustrates a split case study performed by us on PWS birthmark using both wavelengths, showing the superior results with the KTP.

Larger facial telangiectasias

The penetration of laser energy becomes insufficient to heat the full cross-section of vessels greater than 0.5mm in diameter. The KTP/PDL may thermally damage the ceiling of larger vessels and cause transient vasoconstriction, giving a false impression of clearance. We use the long-pulsed Nd:YAG for these indications, as this provides a deeper penetration. Facial telangiectasias are treated with a 2-3mm spot size to limit collateral damage to deeper facial arteries that may occur with larger spot sizes. Intra-ocular metal eye shields must be used when treating vessels near the orbital margin. Treatment within the bony orbit should be carried out with extreme caution.

Figure 5 – Purpura following PDL 595nm treatment for Type 1 Rosacea

Figure 6 – 1 session KTP 532nm for generalised essential facial telangiectasia (before and after)

Figure 7 – Type 1 rosacea, before and 2 weeks after one session of treatment with 532nm 8mm spot

Figure 8 – Split study comparing efficacy of 532nm treatment vs 595nm treatment on the same PWS birthmark

Figure 9 – Treatment of larger nasal telangiectasia with Cutera Excel V 3mm spot 1064nm

Figure 10 – Split Leg Study – Left leg untreated – Right Leg 4/52 post 1 session NdYAG

Bulk heating is mitigated by cooling the skin well and never overlapping shots. A spot-welding technique with spatial gaps between shots is used.

Figure 9 shows a gentleman who has relatively large >0.5mm nasal telangiectasia. These were completely cleared with two sessions of long-pulsed Nd:YAG treatment 4 weeks apart.

Lower Limb telangiectasias and veins

The PDL and KTP are of limited use for leg veins, as their penetration is insufficient for lower limb telangiectasias which are deeper situated. Consequently, any useful photons may reach the roof of vessels and not the whole diameter. They do, however, have a role in the treatment of matting. A side effect of leg vein treatment resulting in the proliferation of small oxyhaemoglobin rich micro-vessels.

For effective treatment, an even temperature increase is required across the whole diameter of the vessel. Longer wavelengths overcome this problem and are effective for lower limb telangiectasias (*Figure 10*). Lasers suitable for leg vein treatment are:

- 940nm diode
- 1064nm Nd:YAG

Low melanin absorption results in a low incidence of post-inflammatory hyperpigmentation, so the longer wavelength lasers can be used safely in Fitzpatrick skin types 1-6. As longer wavelengths are better absorbed by water, bulk heating of the skin is a potential problem. For practical purposes, this can be overcome by using suitable cooling methods such as bulk tissue cooling with refrigerated air devices such as a Zimmer air cooler.

Long pulsed Nd:YAG remains the treatment of choice for telangiectasias and small veins in the lower limbs as the majority are >0.5mm in diameter and are situated deeper in the skin than facial telangiectasias. They also have a greater content of deoxyhaemoglobin which is better absorbed by 1064nm. 3mm spot sizes remain adequate for smaller, more superficial vessels. Larger spot sizes (up to 6mm) can be used with lower fluences for larger reticular veins. However, larger spot sizes create greater discomfort. Use of too high a fluence or too short a pulse duration can result in cavitation and superheated gas formation within the vessel leading to rupture, ulceration and scar formation. The risks with long-pulsed Nd:YAG are generally greater and experience and training is required.

Other Vascular Lesions

Lasers are regularly used for complex lesions such as large haemangiomas, complex hypertrophic port wine stains, lip venous ectasia (venous lakes), periorbital veins, and intraoral lesions. Diagnosing lesions correctly

Photos courtesy of Dr A Hussein

Figure 11 – Treatment of lower leg/medial malleolar area telangiectasia with Cutera Excel V 3mm spot 1064nm

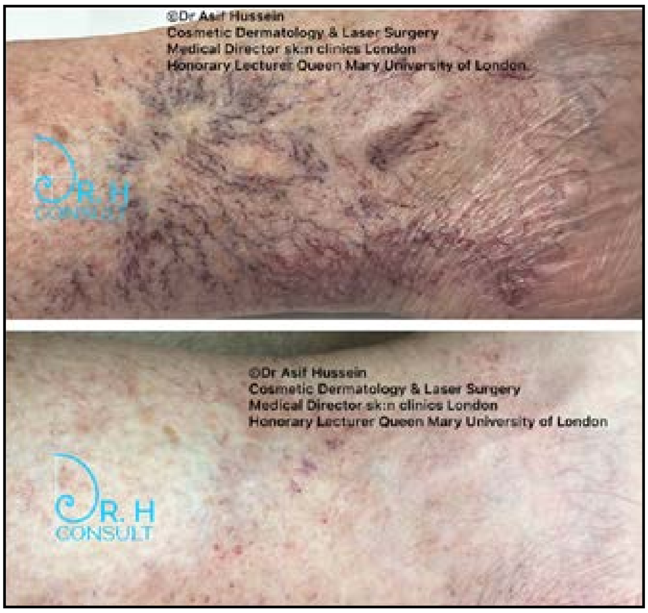
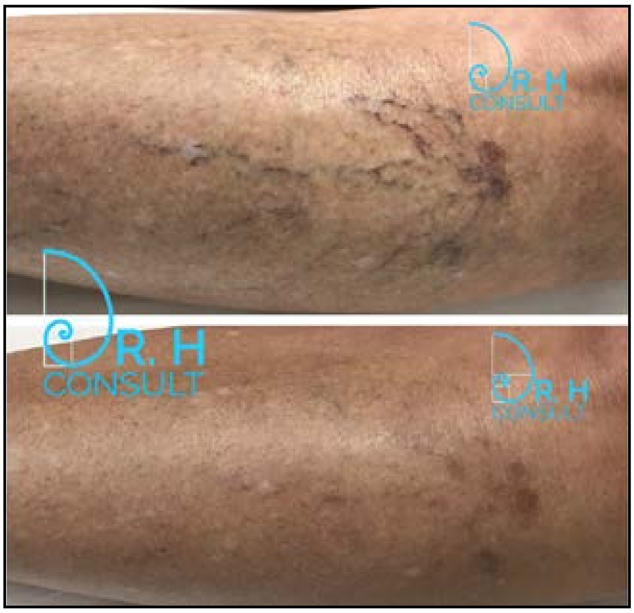


Figure 12 – Treatment of lower leg telangiectasia in darker skin types with Cutera Excel V 3mm spot 1064nm



is important by taking a full history, incorporating dermatoscopy in the assessment and carrying out skin biopsies if there is suspicion, and imaging to understand topography and regional anatomy. It is perfectly reasonable for the non-specialist practitioner to refer such cases to laser specialist providers.

Venous lakes (*Figure 13*) are best treated with the long-pulsed Nd:YAG. A double stack technique can be used with caution. Caution must be used as a larger spot size is necessary, and an excessive fluence may cause ischaemic necrosis of adjacent tissues. In larger lesions, it is safer to treat the lesion over two sessions. Longer pulse durations are used in order to prevent cavitation, gas formation and lesion rupture.
Larger venous and low flow vascular

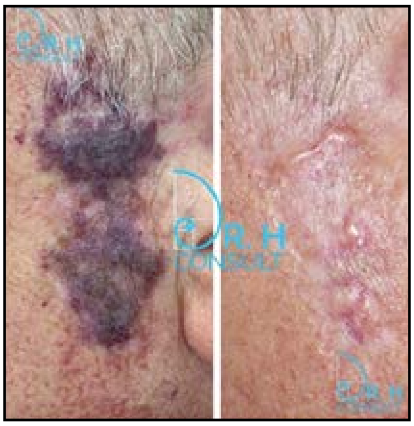
Figure 13 – Treatment of a lower lip venous lake with Cutera Excel V 6mm spot 1064nm

Photos courtesy of Dr A Hussein

malformations can be treated effectively with larger spot size long-pulsed Nd:YAG. Soft tissue imaging is important to precisely map the extent and depth of lesions. Patients must be made aware that there may be a residual deficit once healed as shown in *Figure 14*.

Intraoral lesions

Figure 14 – Treatment of a pre-auricular venous malformation with Cutera Excel V 6mm spot 1064nm. Single session treatment after 6 previous treatments with the PDL without benefit.



The patient in *Figure 15* presented with vascular lesions on the tongue and the roof of the mouth which was significantly impairing his quality of life, with frequent bleeding occurring following trauma from eating. This case was funded under the IFR (Independent Funding Request) by the CCG, and treated successfully with one session with the long-pulsed Nd:YAG.

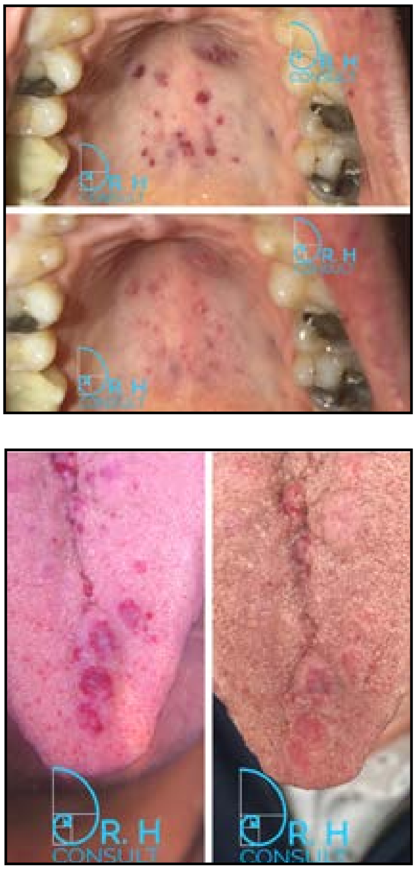


Figure 15 – Treatment of intraoral vascular lesions with Cutera Excel V 4mm spot 1064nm

Conclusions

Optical Coherence Tomography (*Figure 16 - Vivosight OCT – Michelson Diagnostics*) can determine the depth and diameter of vascular targets. We find that this provides valuable information for selecting the correct parameters, especially for complex lesions.

A vascular laser workstation can safely and effectively treat the majority of cutaneous vascular lesions in practice. We offer both 532nm and 595nm wavelengths in practice but conclude that for the everyday common indications of rosacea, facial redness and telangiectasia, a 532nm/1064nm (KTP/Nd:YAG) vascular workstation offers superior outcomes and greater stability, with lower running costs, compared to the 595nm/1064nm (PDL/Nd:YAG).

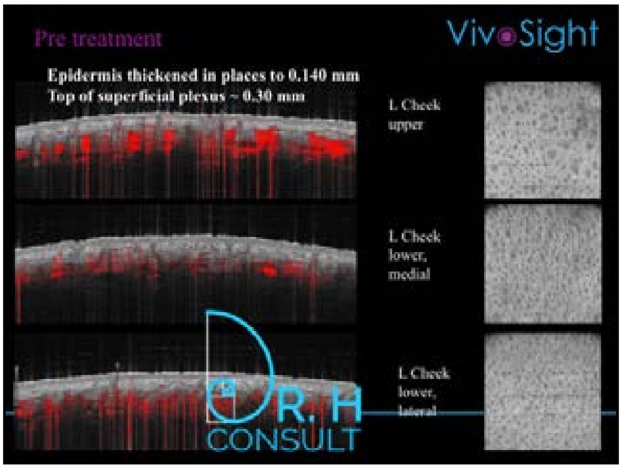


Figure 16 – Optimisation of laser parameters with OCT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Have a brainwave about 'vein' waves!
Dr Asif Hussein and Dr Sajjad Rajpar unravel the laser options when it comes to treating veins and vascular lesions.
Literature

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