Laser 940nm – new, old wavelength – in trans-dermal therapy of vascular lesions

Piotr Sznelewski, MD, Poland

Polish Society of Aesthetic and Anti-Aging Medicine

IMCAS, Paris, Jan 2012

This work was not supported by any direct or non direct funding.
It is under the author's own responsibility.
Different lasers used in trans-dermal therapies of vascular lesions:

- **KTP laser**: 532nm LONG PULSE
- **Dye laser**: 585-595nm
- **Diode Laser**: 940nm
- **Nd:YAG Laser**: 1064nm LONG PULSE
Absorption coefficients (cm\(^{-1}\)) for various chromophores

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>532</th>
<th>595</th>
<th>810</th>
<th>940</th>
<th>1064</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxy HgB (40% Hct)</td>
<td>187</td>
<td>35</td>
<td>3.6</td>
<td>5.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Deoxy HgB</td>
<td>138</td>
<td>96</td>
<td>2.7</td>
<td>3.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Melanin</td>
<td>56</td>
<td>38</td>
<td>13</td>
<td>7.0</td>
<td>5.7</td>
</tr>
<tr>
<td>Water</td>
<td>0.00044</td>
<td>0.0017</td>
<td>0.02</td>
<td>0.27</td>
<td>0.15</td>
</tr>
<tr>
<td>Bloodless dermis</td>
<td>3.0</td>
<td>2.0</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
</tr>
</tbody>
</table>

„Lasers in Dermatology and Medicine” Keyvan Nouri (Editor), Springer 2011, page 7, table 1
Photon absorption of lasers by oxynated or desoxynated blood and water

Endoscopically Based Endonasal and Transnasal Lasersurgery” Hans Scherer, Juergen U.G. Hopf, Marietta Hopf, Diagnostic And Therapeutic Endoscopy (2001)

Piotr Sznelewski, IMCAS, Paris, Jan 2012
KTP laser 532nm LONG PULSE
Dye laser 585-595nm

**High-selective lasers** (the second peak of haemoglobin absorption)

- Very high hemoglobin absorption
- Shallow skin penetration
- Required for trans-dermal therapy of vascular lesions, which diameter of single vessel is under 0.3mm
- High possibility of side-effects caused by melanin absorption
Nd:YAG laser 1064nm
Diode laser 940nm

**Low-selective lasers** (the third peak of haemoglobin absorption)

- Sufficient hemoglobin absorption
- Deep skin penetration
- Required for trans-dermal therapy of vascular lesions, which diameter of single vessel is between 0.3 to 2mm
- Low possibility of side-effects caused by melanin absorption

Piotr Sznelewski, IMCAS, Paris, Jan 2012
Skin penetration of high-selective lasers (left) and low-selective lasers (right)
The effect of absorption depth and vessel size on vessel heating

"Transdermal Laser Treatment of Facial Telangiectasia - Comparison of the 532 nm KTP to the 940 nm Diode Wavelength" Asad Shamma, Faud Ramadan & Kimberly Vonderlieth, Artery and Vein Institute, Melbourne, Florida

Piotr Sznelewska, IMCAS, Paris, Jan 2012
Absorption coefficients of melanin and oxyhemoglobin for various vascular lasers


*Kaudewitz et al.: 940 nm Diode Laser Treatment of Leg Veins*

Piotr Sznelewski, IMCAS, Paris, Jan 2012
Nd:YAG laser 1064nm

Till now, the gold standard in trans-dermal therapy of vascular lesions located on face or legs skin, which diameter of single veins is between 0,3 to 2mm, was Nd:Yag 1064nm. Nd:Yag laser vascular lesion therapy required high density energy even 180-250J/cm2, what caused high painfulness of therapy and could impend side-effects.
Nd:YAG lasers

1064nm

Nd:YAG lasers – solid state lasers:

- heavy, limited-portability
- high electric energy consumption
- high cost of service

Piotr Sznelewski, IMCAS, Paris, Jan 2012
Diode lasers:

- light weight, portable
- low electric energy consumption, ecological
- lower cost of service then solid state lasers
Absorption coefficients (cm$^{-1}$) for various chromophores

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>532</th>
<th>595</th>
<th>810</th>
<th>940</th>
<th>1064</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxy HgB (40% Hct)</td>
<td>187</td>
<td>35</td>
<td>3.6</td>
<td>5.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Deoxy HgB</td>
<td>138</td>
<td>96</td>
<td>2.7</td>
<td>3.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Melanin</td>
<td>56</td>
<td>38</td>
<td>13</td>
<td>7.0</td>
<td>5.7</td>
</tr>
<tr>
<td>Water</td>
<td>0.00044</td>
<td>0.0017</td>
<td>0.02</td>
<td>0.27</td>
<td>0.15</td>
</tr>
<tr>
<td>Bloodless dermis</td>
<td>3.0</td>
<td>2.0</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
</tr>
</tbody>
</table>

„Lasers in Dermatology and Medicine” Keyvan Nouri (Editor), Springer 2011, page 7, table 1
Diode laser 940nm

The third peak of haemoglobin absorption includes wavelength range between 780 and 1100nm.

On the top of this haemoglobin absorption peak located is wavelength 940nm.

The curves (graphs) of light absorption for Oxy HgB (40% Hct) and Deoxy HgB shows that light 940nm is absorbed better then light 1064nm adequately $2.36 \times$ and $5 \times$ higher.
Diode laser 940nm

Higher absorption in hemoglobin of light 940nm then 1064nm, can draw a conclusion, that effective trans-dermal therapy of vascular lesions accomplished by 940nm laser will require lower density of energy then therapy of 1064nm laser, by what will be less painful and safe at the comparable efficacy

Piotr Sznelewski, IMCAS, Paris, Jan 2012
Absorption coefficients of melanin and oxyhemoglobin for various vascular lasers


KaudewitZ et al.: 940 nm diode laser treatment of leg veins

Piotr Sznelewski, IMCAS, Paris, Jan 2012
940nm diode lasers – progress in power

25 W
940nm diode lasers – progress in power

40 W

Piotr Sznelewski, IMCAS, Paris, Jan 2012
940nm diode lasers – progress in power

60 W

Piotr Sznelewski, IMCAS, Paris, Jan 2012
940nm diode lasers – progress in power

120 W

Piotr Sznelewski, IMCAS, Paris, Jan 2012
For sometime on medical market available are diode lasers 940nm with energy power from 25 to 40W.

Nowadays appear new type of lasers still wavelength 940nm but with significantly higher energy power from 100-120W lasers.

In no long future we can expect next generation of cost effective 940nm diode lasers with power 150W or higher.
Figure 3. (A) Small telangiectatic vessels before treatment. (B) Complete clearing of vessels after three treatments.
Figure 4. (A) Larger superficial arborizing vessels before treatment. (B) Remarkable reduction of vessels after three treatments with few residual vessels.
Diode laser 940nm
trans-dermal therapy of vascular lesions

Study Design:

The group of patients with vascular lesions on face or legs. The required condition: diameter of single blood vessel should be between 0.3 to 2mm.
The treatment was accomplished by using trans-dermal laser 940nm therapy and establishing individual effective therapeutic dose, started from 50J/cm², with selection of pulse time in range between 20 – 70ms (depends of diameter of single veins) and working spot size from 1 to 2.5mm. The therapy was repeated 2-3 times.
Diode laser 940nm
trans-dermal therapy of vascular lesions

Results:

On group of 30 patients with face skin telangiectasias, or visible veins on legs skin (the single vein diameter 0.3 – 2mm) undergo trans-dermal treatment by laser 940nm, obtained good effect of therapy by selection of parameters:

- for red veins - energy density: 100-120J/cm²,
- for blue veins - energy density: 60-80J/cm²,
- for both types of veins: pulse time 20-25ms (veins with diameter 0.3-0.6mm) to 60-70ms (veins with diameter 0.6-2.0 mm)
- working spot: 1 -2.5mm (depends of veins diameter).

Piotr Sznelewski, IMCAS, Paris, Jan 2012
Laser trans-dermal therapy of vascular lesions

Practical Tips:

- necessary skin cooling
- direct after treatment - local application of strong anti-inflammatory agent
Skin cooling during laser treatments reduces the level of pain during procedure and secures against side-effects as: post inflammatory hypo- or hiper-pigmation & scars.
Diode laser 940nm trans-dermal therapy of vascular lesions

Conclusions:

Diode laser 940nm with power no less than 100W seems very good therapeutic alternative for laser Nd:Yag 1064nm, giving the possibility of using lower density of energy, what reduce the pain of procedure and possibility of emerge the side-effects by comparable efficacy.
Literature – diode laser 940nm – trans-dermal therapy of vascular lesions:

Kaudewitz, et al.; Treatment of Leg Vein Telangiectases; 1-year results with a new 940 nm Diode Laser; Dermatol Surg 2002; 28; 1031-1034

Study shows that after 1 year the results are even better as after 4 weeks. 75% of patients had 75% or better clearance of spider veins.

Kaudewitz, et al.; Effective Treatment of Leg Vein Telangiectasia with a New 940 nm Diode Laser; Dermatol Surg 2001; 27; 101-106

Study shows that 75% of patients had 50% or better clearance of spider veins.

Baumann, L. Using the 940-nm Laser for Facial Indications; Cosmetic Dermatology 2005; Vol 18:6, 407-410

940nm diode laser is successfully used on facial veins and angiomas.


Study evaluates the efficacy of spider veins with a diameter of 0.4 to 1.4 mm that were treated with a 0.5 to 1.5mm spot size on the 940nm diode laser.
Randomized controlled trial: Comparative efficacy for the treatment of facial telangiectasias with 532 nm versus 940 nm diode laser

Emily Tierney, MD 1 2, C. William Hanke, MD, MPH 1 *
1 Laser and Skin Surgery Center of Indiana, Carmel, Indiana
2 Department of Dermatology, Boston University School of Medicine, Boston, Massachusetts

Conclusions:
While both 532 and 940 nm diode laser produced significant improvement in facial telangiectasias, greater efficacy was found with 940 nm as well as a significantly more tolerable side effect profile.

The 940 nm diode laser is successful used on 14 patients with incompetent vein of Giacomini without serious complications, sometimes in combination with sclerotherapy.

R.G. Bush; Thermal Endovenous Ablation of the Saphenous Vein; Endovascular Today, April 2007

41 patients were different wavelength and power settings and the RF treatment compared regarding mechanism of action and histological finding.

R.G. Bush et al.; 940-nm Laser for Treatment of Saphenous Insufficiency: Histological Analysis and Long-Term Follow-Up; Photomedicine and Laser Surgery 2005; 23(1); 15-19

620 patients were treated with the 940nm diode laser with a high closure rate of 95%, some have already a follow-up period of 3 years. The patented lightguide protection system of Dornier is explained.
Literature – diode laser 940nm – endovenous laser treatment (EVLT):


The steam bubble effect is explained, which is the mechanism of action with a 940 nm diode laser for the endovenous laser treatment.


Basic in vitro and in vivo experiments were done for the endovenous laser treatment. The blood is responsible for damage along the entire vein wall.


This paper gives recommendations on how to write a paper for endovenous laser treatment and which informations should be included.
Literature – diode laser 940nm – surgery and otolaryngology

Hopf et al.; Endoscopically Controlled Laser Therapy of Recurrent Epistaxis with the 940nm Diode Laser; Med Laser Appl 2002; 17; 231-241

The high efficiency of a 940 nm diode laser for sealing hemorrhage-prone areas is shown in a long-term follow-up of 24 months.


This paper shows excellent results of 5 treatments of PCA concerning wound healing. No complications and no growth changes in the surrounding anatomy occurred.


86% of the patients had a clear improvement of nasal airflow 6 months after treatment of hyperplastic inferior nasal turbinates with the Medilas D diode laser.

Sroka et al.: Comparison of Long Term Results after Ho: YAG and Diodee Laser Treatment of Hyperplastic Inferior Nasal Turbinates; Las Surg Med 2007; 39; 324-331

The Dornier diode laser as well as the Ho:YAG laser are both successful treatment options for hyperplastic inferior nasal turbinates. The improvement rate after 3 years is 67-74%.

Piotr Sznelewski, IMCAS, Paris, Jan 2012
Literature – diode laser 940nm – gynecology and neurosurgery


Procedure of TTTS is explained in detail and as first-line treatment for this syndrome with a 100W Nd:YAG or a 60 W diode laser.


Laser coagulation of anastomosis at TTTS with a Nd: YAG or diode laser of at least 60 W output power has higher survival rate as amnioreduction.

Daniel s. J. Choy: Percutaneous Laser Disk Decompression: A 17 Year Experience; Photomedicine and Lasersurgery 2004; 22(5); 407-410

Choy explains the methodology for PLDD. He uses usually Nd: YAG laser and explains that KTP, holmium and diode laser can be used as well.
Thank you very much for your attention

piotr.sznelewski@wp.eu

ph. +48 607601775