Laser Treatment of Hyperpigmentation Disorders: What Modalities to Use and When

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Objectives

- Overview: Lasers Parameters
- Case Presentations: Lasers For Benign Pigmented Lesions
  - Epidermal
  - Dermal
- Complications

Overview

Laser Eradication of Pigmented Lesions: A Review


Overview: Q-Switched (QS) Lasers Pigmented Lesions

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Laser</th>
<th>Indication*</th>
</tr>
</thead>
<tbody>
<tr>
<td>532 (green)</td>
<td>Fld YAG</td>
<td>Epidermal pigmented lesions</td>
</tr>
<tr>
<td>694 (red)</td>
<td>Ruby</td>
<td>Epidermal and dermal pigmented lesions</td>
</tr>
<tr>
<td>755 (infrared)</td>
<td>Alexandrite</td>
<td>Epidermal and dermal pigmented lesions</td>
</tr>
<tr>
<td>1064 (infrared)</td>
<td>Nd:YAG</td>
<td>Dermal pigmented lesions</td>
</tr>
</tbody>
</table>

*Epidermal pigmented lesions e.g. ephelides, lentigines, café-au-lait macules, nevus spilus.
Mixed pigmented lesions e.g. Becker’s nevus, melasma.
Dermal pigmented lesions, e.g. nevus of Ota, nevus of Ito, Hori’s nevus, congenital nevus.
**Picosecond Lasers for Benign Pigmented Lesions**

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Laser</th>
<th>Pulse Duration</th>
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</thead>
<tbody>
<tr>
<td>532/670/1064</td>
<td>Enlighten (Cutera)</td>
<td>Nanosecond &amp; picosecond</td>
</tr>
<tr>
<td>532/755/1064</td>
<td>PicoSure (Cynosure)</td>
<td>750 picoseconds/550 picoseconds</td>
</tr>
<tr>
<td>532/785/1064</td>
<td>Picoway (Syneron/Candela)</td>
<td>450-750 picoseconds</td>
</tr>
</tbody>
</table>

**Picosecond Lasers** for Benign Pigmented Lesions

- Laser Induced Optical Breakdown (LIOB)

**Overview: Non-Ablative Fractional Devices**

<table>
<thead>
<tr>
<th>Company</th>
<th>Device</th>
<th>Wavelength (nm)</th>
<th>Spot Size</th>
<th>Pulse Duration</th>
<th>Non-Energy Max (mJ)</th>
<th>Energy (mJ)</th>
<th>Depth (microns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solta</td>
<td>Fraxel DUAL</td>
<td>1550</td>
<td>5, 10</td>
<td>9</td>
<td>5-40%</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Cynosure</td>
<td>Affirm 1540</td>
<td>1540 Stamp</td>
<td>10</td>
<td>8 J/cm²/pulse</td>
<td>1000</td>
<td>1400-2000</td>
<td></td>
</tr>
<tr>
<td>Palomar</td>
<td>StarLux IR</td>
<td>1540 Stamp</td>
<td>10</td>
<td>8 J/cm²/pulse</td>
<td>1000</td>
<td>320-600</td>
<td></td>
</tr>
</tbody>
</table>

**Non-Ablative Fractional Resurfacing (NAFR)**

- Intact stratum corneum
- Thousands of microscopic wounds completely surrounded by viable tissue for rapid healing
- Immediate and delayed therapeutic results
  - Epidermal and dermal coagulation for resurfacing
  - Collagen denaturation for deep remodeling
- Safe on neck, trunk, extremities

**Case Presentations**

Benign EPIDERMAL Pigmented Lesions

- Cafe-au-lait Macules (CALMS)
- Freckles/Lentigines
- Seborrheic Keratoses
- Nevus Spilus
After 1 year of 4 treatments with 755-nm Q-Switched Alexandrite Laser:

- CALM
- 1 year after 4 treatments

After 2 sessions with 755-nm QS Alexandrite Laser:

- CALM
- After 2 Sessions
- 755-nm, 3mm, 5.5-6.5 J/cm²

After 3 sessions with 755-nm QS Alexandrite Laser:

- CALM
- After 3 Sessions
- 755-nm, 3mm, 5.0 J/cm²

After 3 treatments with 532-nm QS Nd:YAG Laser:

- CALM
- After 3 treatments of 532-nm QS Nd:YAG
3/1/2017

532-nm QS Nd:YAG

CALM
After 1 Session

694-nm QS Ruby Laser

CALM
9 Month Follow-up
After 2 Sessions
5 mm spot, 3.5-4.0 J/cm² (694 nm)

755-nm QSAL

CALM
After 2 treatments

1550-nm Erbium-Doped Fiber Laser

CALM
After 7 sessions

755-nm Picosecond Laser
CALM

After 2 treatments

532-nm Picosecond Laser
CALM vs CMN
After 2 treatments


MK Levin, MD, Y Ng, MD, YSC Bae, JA Bower, Geronemus RG. LSM 48:175-187 (2010)
Standard Treatment Parameters for Pigmented Lesions

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Laser</th>
<th>Spot size (mm)</th>
<th>Fluence (J/cm²)</th>
<th>Retreatment interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lentigo</td>
<td>QS ruby</td>
<td>6.5</td>
<td>2.0 – 4.0</td>
<td>4 – 8 weeks</td>
</tr>
<tr>
<td></td>
<td>QS Nd:YAG (1064)</td>
<td>3</td>
<td>0.7 – 1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QS Alexandrite</td>
<td>3</td>
<td>0.0 – 4.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pulsed dye (510 nm)</td>
<td>5</td>
<td>0.7 – 1.0</td>
<td></td>
</tr>
<tr>
<td>Coffee-bean macules</td>
<td>QS ruby</td>
<td>6.5</td>
<td>1.0 – 1.5</td>
<td>4 – 8 weeks</td>
</tr>
<tr>
<td></td>
<td>QS Nd:YAG (1064)</td>
<td>3</td>
<td>2.5 – 3.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QS Alexandrite</td>
<td>3</td>
<td>4.0 – 5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pulsed dye (510 nm)</td>
<td>5</td>
<td>2.0 – 3.5</td>
<td></td>
</tr>
<tr>
<td>Fundal’s nevus</td>
<td>QS ruby</td>
<td>6.5</td>
<td>2.0 – 4.5</td>
<td>4 – 8 weeks</td>
</tr>
<tr>
<td></td>
<td>QS Nd:YAG (1064)</td>
<td>3</td>
<td>1.5 – 2.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QS Nd:YAG (1064)</td>
<td>1</td>
<td>4.0 – 5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QS Alexandrite</td>
<td>3</td>
<td>5.0 – 6.0</td>
<td></td>
</tr>
<tr>
<td>Nerve spots</td>
<td>QS ruby</td>
<td>6.5</td>
<td>1.0 – 1.5</td>
<td>4 – 8 weeks</td>
</tr>
<tr>
<td></td>
<td>QS Nd:YAG (1064)</td>
<td>3</td>
<td>1.5 – 2.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QS Nd:YAG (1064)</td>
<td>1</td>
<td>4.0 – 4.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QS Alexandrite</td>
<td>3</td>
<td>6.0 – 6.0</td>
<td></td>
</tr>
</tbody>
</table>

Melasma – Pathophysiology

- Pathophysiology remains unknown
- Estrogen and UV
- Melanocytes are more active
- Overproduction of melanin
- Pigment incontinence (dermal melanophages)
- Vascular component
- Epidermal estrogen receptor overexpression?
- High recurrence rate

Advances in Laser Treatment of Melasma

- Multiple, gentle treatments are effective (less is more) with lengthened treatment intervals.
- Low-fluence (~2 J/cm²) 1,064-nm Q-switched Nd:YAG laser
- Low-density (5%), low-energy (5 mJ) 1927-nm fractional diode laser
- Pulsed dye laser
- Combination therapy targeting pigment and vasculature may be ideal to prevent frequent relapses.
1064-nm Low-Fluence Nd:YAG Melasma

- 27 women, FST II-V
- Microdermabrasion
- 1.6-2.0 J/cm², 5-6 mm
- q month, up to 4 sessions
- Sun protection
- 4% hydroquinone BID
- 0.05% retinoic acid QHS
- 11/27 women > 95% clearance


1927-nm Fractional Low-Power Diode Laser For Melasma and PIH

- 30 patients, FST I-VI had up to six sessions q2 weeks
- Low-density, low-energy: 5-7.5% coverage, 5 mJ, average 4-12 passes
- Significant reduction of hyperpigmentation without exacerbation


1927-nm Fractional Low-Power Diode Melasma, Skin Type III

Baseline

After 2 sessions

1927-nm Fractional Low-Power Diode Laser for Treatment of Melasma

Pre-Treatment

Post Topical Skin Brightener for 3-months

Post Three Laser Treatments and Skin brightener 1927-nm, tx level low

Tranexamic Acid

Vascular Targeted Therapy in Patients Exhibiting Telangiectatic Erythema within Lesions of Melasma

Melasma

After 3 months of Tranexamic Acid
Melasma Treatment with Pulsed-Dye Laser and Triple Combination Cream

- Left forehead triple combination cream, right forehead both the cream and PDL.
  - Three PDL treatment sessions at 3-week intervals on the right forehead.
  - Compression handpiece 10mm, 1.5 ms, 7 J/cm²
  - 2nd pass regular handpiece 7mm, 20ms, 10J/cm², DCD 30/40


Long-Lasting Effect of Vascular Targeted Therapy of Melasma

- Central forehead with clearing of melasma at 3-year follow up (A) matched perfectly with area treated with combination approach of Kligman’s trio and PDL (B).


Vascular Characteristics of Melasma

- Immunohistochemistry for factor VIII α-related antigen revealed enlarged and elongated blood vessels in the upper dermis (B), as compared with perilesional normal skin (A).
- Computer assisted morphometric analysis of factor VIIIα-related antigen stained sections revealed a significant increase in vessel size (C), vessel density (D) and the relative area covered by blood vessels (E), as compared with perilesional normal skin.


Retrospective Analysis of the Treatment of Melasma Lesions Exhibiting Increased Vascularity With the 585-nm Pulsed Dye Laser Combined With the 1064-nm Fractional Low-Powered Diode Laser

Vascular Targeted Therapy
For Melasma

• Retrospective review, 10 females and 1 man, average age 38.7 years, FST II-IV
• Tx at 4-6 week intervals, average 4 treatment sessions, average follow-up of 90 days.
• Vascular component treated with 595-nm long-pulsed dye laser.
  • 10 mm spot, 7.5-8.5 J/cm2, 30-20 ms, DCD 30/30
• Hyperpigmentation treated with the 1927-nm fractional low-powered diode laser (Clear & Brilliant Permea).
  • 5% treatment coverage, 8 passes
  • Energy of 5mJ
  • Zimmer forced air cooling
  • Sun protection and skin brightener

Retrospective Analysis of the Treatment of Melasma Lesions Exhibiting Increased Vascularity With the 595-nm Pulsed Dye Laser Combined With the 1927-nm Fractional Low-Powered Diode Laser

Vascular Targeted Therapy For Melasma

• Spectrophotometry used to identify telangiectatic erythema underlying lesions of melasma

Nevus of Ota
Nevus of Ota
After 6 treatments
1064-nm QS Nd:YAG + NAFR

Nevus of Ota
After 13 Sessions
1064-nm, 4mm, 4 J/cm²


1064-nm QS Nd:YAG + 1550-nm Erbium-Doped Fiber Laser

Nevus of Ota
After 3 treatments of NAFR and 1064-nm QS Nd:YAG

1064-nm QS Nd:YAG + 1550-nm Erbium-Doped Fiber Laser

Baseline
After 10 NAFR + 6 QS Nd:YAG treatments

Followed by 4 Sessions 1064-nm, 7mm, 2.6-3 J/cm²

Baseline
6 Sessions 1550-nm, 15-16 mJ, 17% coverage
After 6 Sessions
Nevus of Ota

1064-nm QS Nd:YAG + 1550-nm Erbium-Doped Fiber Laser
Skin Type IV


1064-nm QS Nd:YAG + 1550-nm Erbium-Doped Fiber Laser

Nevus of Ota

After 11 treatments of 1,064-nm QS Nd:YAG and 9 NAFR treatments

After 6 treatments of 1,064-nm QS Nd:YAG followed by 1 Picosecond laser treatment

1064-nm QS Nd:YAG + Picosecond Laser

1064-nm QS Nd:YAG + 1550-nm Erbium-Doped Fiber Laser

Nevus of Ota

After 11 treatments of 1,064-nm QS Nd:YAG and 9 NAFR treatments

1064-nm QS Nd:YAG + Picosecond Laser

Nevus of Ota

After 6 treatments of 1,064-nm QS Nd:YAG followed by 1 Picosecond laser treatment

Fractionated 1440-nm Nd:YAG Nevus of Ota

755-nm QSAL Nevus of Ota

Before 4 months after 2 sessions 3.5-4 J/cm²


755-nm Picosecond Laser Nevus of Ota

Baseline 6 months after 11 sessions

755-nm Picosecond Laser Nevus of Ota

Before 4 months after 2 sessions 3.5-4 J/cm²


755-nm Picosecond Laser Nevus of Ota

Before 4 months after 2 sessions 3.5-4 J/cm²


755-nm Picosecond Laser Nevus of Ota

Baseline 6 months after 11 sessions

755-nm Picosecond Laser Nevus of Ota

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Baseline 6 months after 11 sessions

755-nm Picosecond Laser Nevus of Ota

Before 4 months after 2 sessions 3.5-4 J/cm²


755-nm Picosecond Laser Nevus of Ota

Baseline 6 months after 11 sessions
Becker’s Nevus

After 4 treatments of 1,064-nm QS Nd:YAG followed by 8 Picosecond treatments

**Nevus of Ota**

**Non-Ablative Fractional Photothermolysis**

Becker’s Nevus

After 5 sessions

1,550-nm, 6-10 mJ, Tx Level 7-8


**1064-nm LP Nd:YAG + 1550-nm Erbium-Doped Fiber Laser**

Becker’s Nevus

1064nm, 18mm, 1-5ms, 10J/cm2

1550-nm, 9-30 mJ, tx level 5-7

Balaraman, B, Friedman, PM. Hypertrichotic Becker’s nevi treated with combination 1,550-nm non-ablative fractional photothermolysis and laser hair removal. LSM 48:350-3 (2016).

**755-nm QSAL + 1550-nm Erbium-Doped Fiber Laser**

Becker’s Nevus

After 9 sessions

755-nm, 8J/cm², 3mm

1550-nm, 30-70 mJ, tx level 7-11

Balaraman, B, Friedman, PM. Hypertrichotic Becker’s nevi treated with combination 1,550-nm non-ablative fractional photothermolysis and laser hair removal. LSM 48:350-3 (2016).

**1064-nm LP Nd:YAG + 1550-nm Erbium-Doped Fiber Laser**

Becker’s Nevus

After
Congenital Nevus

694-nm QS Ruby

4 Month Follow-up
After 4 Sessions
5 mm spot, 3.5-4.0 J/cm² (694 nm)

Congenital Nevus

755-nm LP Alexandrite

Small Congenital Nevus

After 2 Sessions
755-nm, 18 mm, 18 J/cm², 3ms

755-nm LPAL and QSAL

Small Congenital Nevus

After 6 Sessions

Minocycline Hyperpigmentation
Hemosiderin Deposition
Post-Inflammatory Hyperpigmentation

NAFR & QSAL FOR MCN Hyperpigmentation
Fractional Assisted Laser Pigment Removal

Minocycline Hyperpigmentation
S/P 1550-nm NAFR + QSAL

Treatment of Minocycline Hyperpigmentation

- NAFR 1550-nm created MTZs in areas of high pigment concentration.
- Q-switched 755-nm was utilized immediately after to further fragment the pigmentation
  - lymphatic channels
  - transepidermal elimination
  - faster removal of the pigmentation.

Fractional Laser & Light Treatment

Hemosiderin Deposition
S/P PDL + NAFR + QSAL

694-nm QS Ruby
PIH - Post Sclerotherapy

Before
2 Month Follow-up
After 2 Sessions
5 mm spot; 3.0-3.5 J/cm² (694 nm)

1550-nm Erbium-Doped Fiber Laser

PIH
After 4 Sessions
1550nm, 15 mJ, tx level 6

1927-nm Fractional Low-Power Diode

PIH
4 weeks After 3 Sessions

1927-nm Fractional Low-Power Diode

PIH
After 9 treatments
Complications

Worsening of Subclinical Melasma
Post-inflammatory Hyperpigmentation (PIH)
Delayed or Misdiagnosis of Melanoma

Ultraviolet Photography

- Subclinical melasma is difficult to diagnose under normal light.
- UV light enhances the appearance of epidermal pigmentation.
- In one study, UV photography identified 63/223 (28.3%) cases of subclinical melasma.
- Subclinical melasma may be exacerbated with aggressive treatment.

Laser Treatment of Melasma: Ensuring Safety

- Broad spectrum, high SPF before and after treatment session.
- Combination treatment with topical bleaching creams as part of pre- and post- treatment regimen.
  - Synergy between lasers and medications
  - HQ 4%, Retinoids, Glycolic acid, Vitamin C, Phloretin, Ferulic acid, Lignin Peroxidase
- Counsel melasma patients about switching to low estrogen birth control pills or discontinuing prior to initiating laser treatment if possible.

Laser Treatment of Melasma: Ensuring Safety in FST IV-VI

- Consider low potency topical steroids and NSAIDs after laser procedures.

Laser Treatment of Melasma: Ensuring Safety in FST IV-VI

- Use low fluences, longer wavelengths and pulse durations
- Lengthen intervals between successive treatments
- Ensure appropriate cooling times and technique during and after treatment.
- Provide detailed post-op instructions

PIH After IPL
PIH After 1450-nm Diode Skin Type IV

1550-nm Erbium-Doped Fiber Laser + 1927-nm Fractional Low-Power Diode Laser

PIH After 4 treatments of NAFR + 1 1927-nm treatment

PIH After 1550-nm

PIH After 1927-nm

Complications

Complications

Standard

Cross-Polarized
Summary

• Multiple laser therapies are available to address benign pigmented lesions in various skin types.
• Melasma is often refractory and requires combination therapy.
• Prudent selection of laser parameters and patient education are pivotal in preventing complications.

Stay Tuned-The Future is Bright!

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