

Current Standards in Light-Based Hair Reduction
Edward Zimmerman, MD

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The following potential conflict of interest relationships are germane to my presentation.
Speakers Bureau: Alma Laser.

Why Provide Hair Removal?

- One of the most popular (top 5) non-surgical cosmetic procedures in the United States
- Since 2003, the number of women seeking hair removal exceeded the number of men nearly 4:1
- Has become the second most requested non-surgical cosmetic procedure by men in the United States

Market for Hair Removal

- In 2005, more than 12 million laser hair removal treatments were performed, generating over \$2.7 billion
- More than 133 million waxing treatments were performed, generating over \$4 billion
- By 2010, laser hair removal treatments are expected to grow to \$3.5 billion in revenue

2005 Medical Insight, Inc. Epilation Market Study

Laser Hair Removal Popularity

- ASAPS 2009 Procedural Statistics list laser hair removal as the third most popular nonsurgical cosmetic procedure
- ASAPS 2009 list laser hair removal as the second most popular nonsurgical cosmetic treatment for men and the third most popular nonsurgical cosmetic treatment for women

Hair Removal Revenue Potential

<i>Monthly Business Mix</i>	<i>Treatments per Month</i>	<i>Gross Income per Month</i>	<i>Treatments per Week</i>	<i>Treatments per Day</i>	<i>Treatment Time per Day (min)</i>
Upper lip	11	\$1650.00	2.75	0.55	5.50
Legs	8	\$2800.00	2	0.4	12.00
Bikini	7	\$2100.00	1.75	0.35	5.25
Back	6	\$3600.00	1.5	0.3	10.50
Vascular	12	\$3900.00	3	0.6	15.00
Monthly Totals	44	\$14,050.00	11	2.2	48.25 min./day
Monthly Gross		\$11949.00			4.02 hours/week
Annual Gross		\$143,388.00			

Methods of Hair Removal

- Shaving
- Waxing
- Tweezing
- Depilatory Cream
- Vaniqa Cream
- Electrolysis
- Laser/ IPL
- ELOS

Successful Hair Practice



Successful Hair Reduction

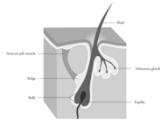
- Laser hair reduction is a process that occurs over a full calendar year
- Requires time and financial commitment
- Patients must receive excellent clinical outcomes
- Treatments must be time efficient, safe, and comfortable

Successful Hair Reduction

As in all other aesthetic procedures, successful hair reduction treatments require:

- Educating patients to expect realistic outcomes
- Educating staff to achieve excellent reproducible results

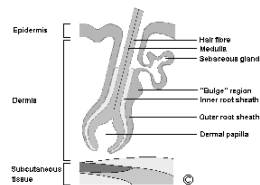
Anatomy of Human Hair



Hair is composed of keratinous fibers that grow from epithelial follicles over the surface of the skin.

Anatomy of Human Hair

- Hair shaft
- Hair bulb
- Sebaceous gland
- Eccrine gland



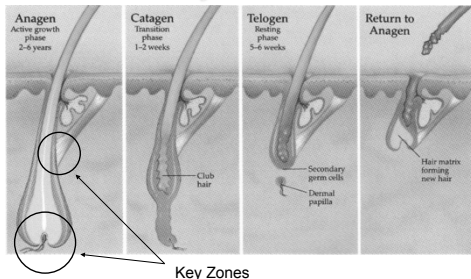
Two Major Types of Hair

- Terminal
 - Long, thick, and pigmented with melanin
 - Found on underarms, genital areas, eyebrows, scalp, arms, chest, face, and back
- Vellus
 - Short, small in diameter, non-pigmented
 - Found on areas such as the forehead

Hair Regeneration

- Papilla
 - Deep in the dermis
 - 3-7 mm from the skin surface
- “Bulge”
 - Near the attachant point of the Arrector Pili
 - 1.5 mm below the epidermis

Phases of Hair Growth



Hair can be damaged during the active growth phase

Three Phases of Hair Growth

Anagen

Catagen

Telogen

Hair Growth Cycles

Anagen Phase

- Active hair growth
- Bulb and papilla develop and cells multiply
- Hair contains an abundance of melanin
- Only stage that hair is susceptible to treatment by laser/IPL

Hair Growth Cycles

Catagen Phase

- A short (three week) stage of regression
- Cell division stops and lower portion of the follicle begins to be reabsorbed by the surrounding cells

Hair Growth Cycles

Telogen Phase

- Hair falls out in preparation for development of new hair
- Dormant stage- - - no growth

Richards - Merhag

	% telogen	% anagen	Telogen duration	Anagen duration	Density Hair / cm ²	Follicle depth
Scalp	13	85	3-4 mnths	2-6 yrs	350	3-5 mm
Eyebrow	90	10	3 mnths	4-8 wks		2-2.5 mm
Ear	85	15	3 mnths			
Cheeks	30-50	50-70		1 yr	800	2-4 mm
Beard-chin	20	70	10 wks	16 wks	500	2-4 mm
Upper lip	35	65	6 wks	6 wks	500	1-2.5 mm
Axillae	70	30	3 mnths	4 mnths	65	3.5-4.5 mm
Trunk	NA	NA			70	2-4.5 mm
Bikini	60	30	3 mnths	4 mnths	70	3.5-5 mm
Arm	70	20	18 wks	13 wks	80	2-4.5 mm
Leg	70	20	24 wks	16 wks	60	2.5-4 mm
Breast	70	30			65	3-4.5 mm

Laser treatment has been shown to interrupt these rates

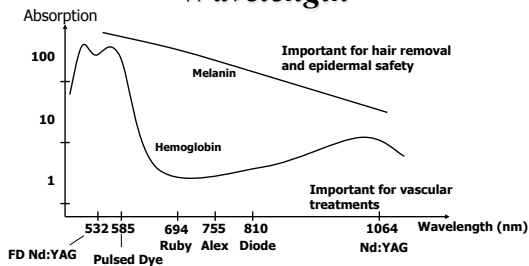
When Should Hair be Treated?

- Treat during Anagen phase.
- Number of treatments predicted by Richards-Merhag chart
- Example:
 - 20% of typical leg hair is in Anagen phase
 - at least 5 treatments to get maximum hair reduction
- Repeat: every 6 to 8 weeks

Variables of Hair Growth

- Male vs. Female
- Hormonal Changes
 - Pregnancy, Menopause, etc.
- Certain endocrine disorders and hormonal diseases or syndromes
 - PCOS, Cushing's Disease, etc.
- Certain medications
 - BCP's, HRT, etc.
- Age
- Diet or exercise

Laser Absorption vs. Wavelength



Melanin Absorption

- Melanin absorption coefficient of the hair shaft and bulb is roughly two to six times that of the epidermis

Ross et al. Theoretical considerations in laser hair removal. Dermatol Clin 1999;17:333-355

Fitzpatrick's Classification

- I: very white, always burns
- II: white, usually burns
- III: white to olive, sometimes burns
- IV: brown, rarely burns
- V: dark brown, very rarely burns
- VI: black, never burns

Laser Hair Reduction Lasers & Devices

Ruby: 694 nm

- Appropriate for skin types I-III
 - Dark to light brown hair
 - Fine to coarse in diameter
- Polderman MC et al. *Efficacy, tolerability, and safety of a long-pulsed ruby laser system in the removal of unwanted hair. Dermatol Surg 2000;26(3):240-3.*
 - Hair counts reduced by approximately 30% after single treatment
 - Hair counts reduced by approximately 60% after 3-4 treatments

Ruby Devices

- Palomar E2000
- Sharplan Epitouch Ruby
- Aesclepiion-Meditec Ruby Star
- Wavelight Sinon

Alexandrite: 755 nm

- Appropriate for skin types I-IV
 - Dark to light brown hair
 - Fine and coarse in diameter
- *McDaniel et al. Laser Hair Removal: a review and report on the use of the long-pulsed alexandrite laser for hair reduction. Dermatol Surg 1999;25:425-30*
 - 45-56% reduction in hair growth in lip, leg, back at 6 months after one treatment with variable pulse alexandrite laser

Alexandrite Devices

- Cynosure Apogee
- Candela Gentlelase
- Sharplan Epitouch ALEX
- Light Age Epicare

Diode: 800/940 nm

- **Appropriate for skin types I-IV**
 - Dark to light brown hair
 - Coarse in diameter
- *Lou, WW et al. Prospective study of hair reduction of diode laser (800 nm) with long term follow-up. Dermatol Surg 2000;26:428-32.*
 - Long term results suggest that diode laser is very effective for removal of dark terminal hair

Diode Devices

- **Alma Soprano**
- **Lumenis LightSheer Duet**
- **Palomar SLP1000**
- **Aesclepion-Meditec MedioStar**

Nd:YAG: 1064 nm

- **Appropriate for skin types I-VI**
 - Dark to medium brown hair
 - Coarse to medium in diameter
- *Goldberg DJ, Samady JA. Evaluation of long-pulse Q-switched Nd:YAG laser for hair removal. Laser Surg Med 2001;28(2):159-61.*
 - Long term results suggest Nd:YAG effective for removal of dark hair safely in all skin types
- *Ross et al. Treatment of pseudofolliculitis barbae in skin types IV-VI with long-pulsed Nd:YAG laser. J Am Dermatol 2002;47(2):2263-70.*
 - Long term results suggest that Nd:YAG effective for treatment of pseudofolliculitis barbae in darker skin types

Nd:YAG Devices

- Aerolase LightPod Neo XT
- Cutera CoolGlide
- Laserscope Lyra
- Candela Gentle YAG
- Cynosure Acclaim
- DEKA PhotoSilk Plus
- Sciton Profile
- Lumenis Vasculite

Intense Pulsed Light

- Appropriate for skin types I-IV
 - Dark to light brown hair
 - Coarse to medium in diameter
- *Trolius, A. Hair Removal with second generation broad spectrum intense pulsed light source-a long term follow-up. J Cutan Laser Ther 1999;1(3):173-8.*
 - Long term results suggest IPL effective for hair reduction

Intense Pulsed Devices

- Lumenis Quantum
- Cynosure Photolight
- Palomar Estelux
- Radiancy Spa Touch
- Derma Med USA Quadra Q4
- Sciton BBL

Hair Removal Lasers & Devices

- Intense Pulsed Light + Nd:YAG
 - Lumenis Vasculite Elite
 - Palomar Starlux
- ELOS Technology
 - Syneron Aurora DS

Laser Hair Removal Indications

- Hirsutism
- Hypertrichosis
- Cosmetic
- Folliculitis

Medical History Considerations

- Conditions causing hypertrichosis
- Local or recurrent skin infection
- History of herpes simplex or genitalis
- Keloid/hypertrophic scarring tendency
- Vitilgo
- Psoriasis
- Previous treatments

Medical History Considerations

- Recent sun, tanning bed, or sunless tanning exposure
- Onset of hair regrowth
- Tattoos
- Patient lifestyle

Contraindications

- Photosensitizing medications
- Presence of tattoo in treatment area
- Psoriasis
- Accutane
- Recent UV exposure
- Gold therapy
- Vitiligo

Pre-Treatment Instructions

- No bleaching, tweezing, waxing, depilatory creams four weeks prior to treatment
- Avoid Retin-A, AHA, or glycolic acid one week prior to treatment
- Avoid sun exposure, tanning, and self-tanning product two weeks prior to treatment
- Shave treatment area 24 hours prior
- Prophylax for herpes simplex if indicated

Clinical Endpoints

- Hairs visible burned to surface
- Odor of burnt hair
- Hairs *may* simply fall out
- Edema
- Erythema

Post Treatment Instructions

- Avoid harsh topical agents
- Avoid sun exposure for two weeks
- Shaving permissible between treatments
- Follow up treatment schedule six to eight weeks

***Important Features of Laser
Hair Removal Devices***

***Important Clinical
Parameters***

- Maximum hair count reduction per treatment
- Treats all skin types
- Minimal pain
- Designed for safe operation
- Highest speed

Important System Features

- Pulse width must be less than the thermal relaxation time (10-400ms)
- Fluence: 20 to 120 Joules/cm² - hair
- Contact cooling

***Important System Features
Cont.***

- Beam shape: square (top hat)
- Speed: average
- Scanning devices

Pulse Width

A pulse of the *optimum* time duration heats both the bulb and the bulge of the follicle to a necrotic temperature $\sim 70^{\circ}\text{C}$.



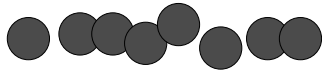
Three-dimensional simulation of the peak tissue temperature (at the time the pulse ends).

A *longer* duration pulse gives time for heat to flow laterally out of the follicle producing a lower peak temperature. If the fluence is increased additional tissue adjacent to the follicle will be damaged and pain is increased.



Three-dimensional simulation of the peak tissue temperature (at the time the pulse ends).

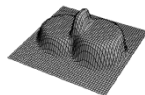
Pulse Stacking: A Problem With Hand Delivery of Pulses



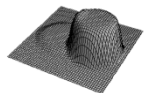
When pulses are applied next to one another, the epidermis heated by the first pulse may still be warm when the second pulse arrives. The "double hit" or "pulse stacking" can result in blisters. The problem will vary with the amount of overlap, which is not well controlled with hand delivery. A model of this effect is shown in the next slide.

Pulse Stacking

After a pulse has deposited heat in tissue, the elevated temperature will diminish with time. If the positions of two successive pulses overlap, the temperature rise can be greater than that produced by either pulse alone and may overheat the dermal/epidermal junction.



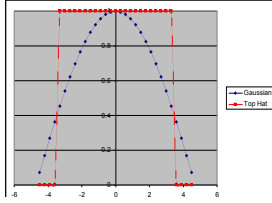
Pulse stacking occurs when the temperature rise produced by an earlier pulse has not dissipated before an adjacent pulse arrives.



When the time between pulses is longer, the temperature rise produced by the first pulse has dissipated.

Energy Distribution

Comparison of a 10 mm diameter Gaussian spot with a 6.4 mm diameter square (Top Hat) spot. The square distribution delivers useful energy to a larger spot.



Before and After Photos

Hair Removal

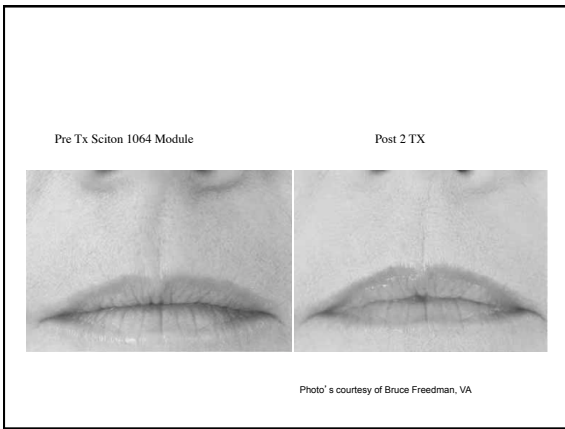
Pre Tx with 1064nm module

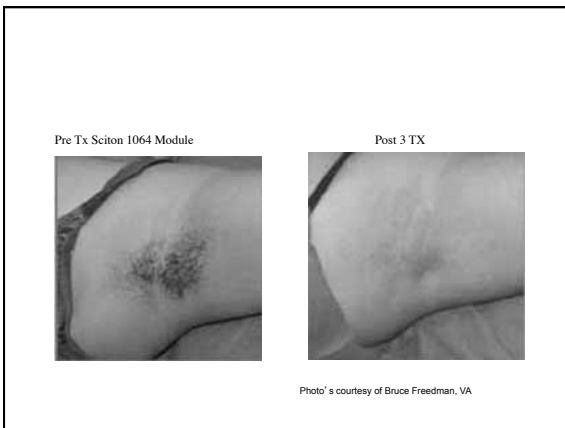
One Month Post ITX

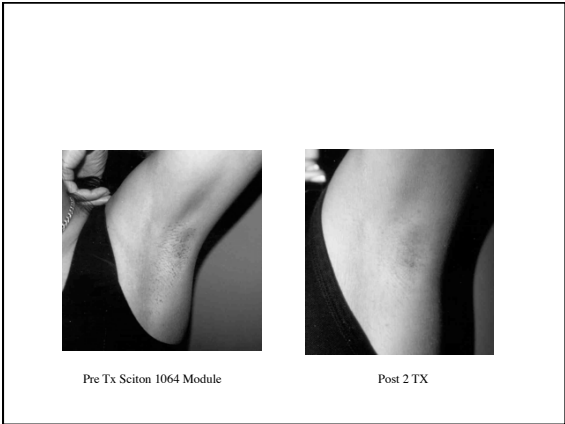


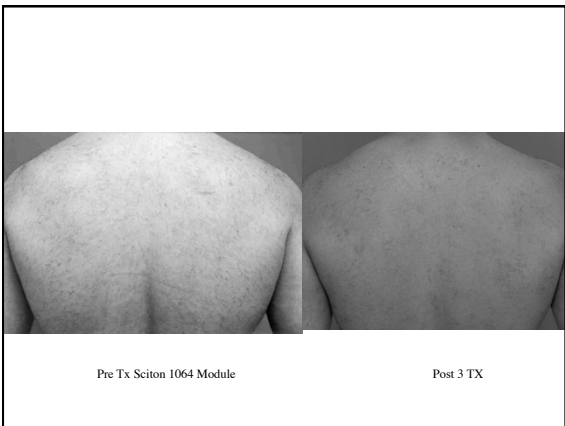
Photos' s courtesy of Arkansas Laser Solutions, Fayetteville, AR 72703

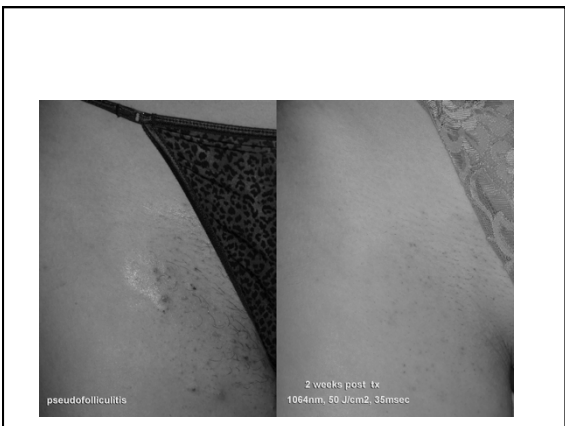


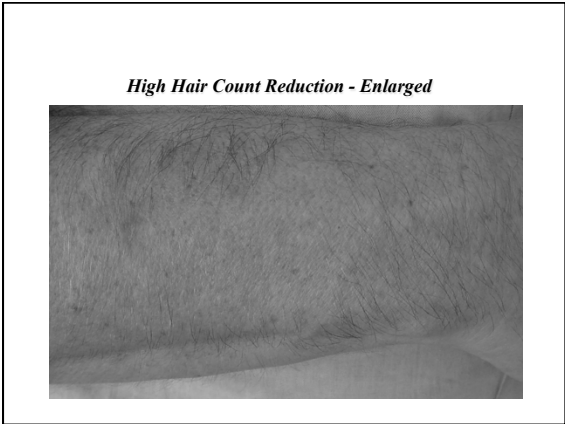




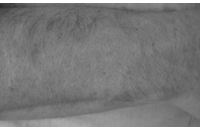









High Hair Count Reduction



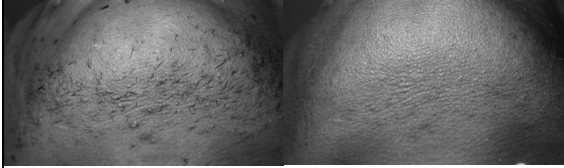
- Tx I Sept 15, 2000: 70 Joules/cm² – 20 msec
- Reduction at Sept 29, 2000: 64%
- Tx II Nov 13, 2000: 70 Joules/cm² – 20 msec
- Reduction at Nov 27, 2000: 95%
- Reduction at Apr 22, 2002: 100%

Before and After Photos

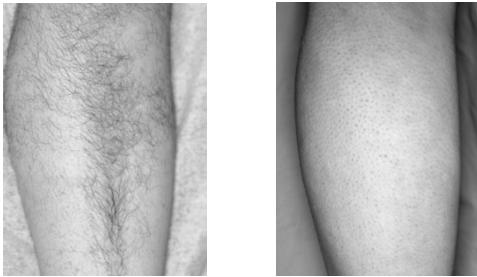


Photos Courtesy of Dr. Don Groot

Before and After Photos

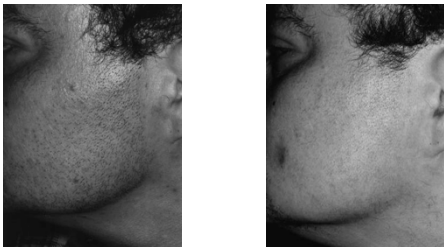


Photos Courtesy of Dr. Sam Lederman



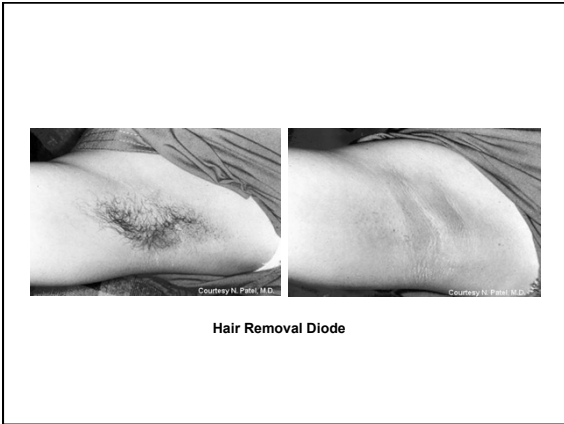
Hair Removal Diode

Photos Courtesy of Valeria Campos, MD; Christine Dierickx, MD; R. Rox Anderson, MD, MD Wellman Laboratories of Photomedicine, Harvard Medical School, Boston, MA

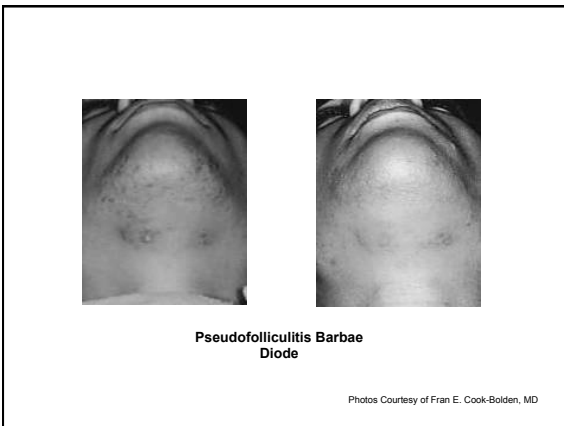


Hair Removal Diode

Photos Courtesy of Rube Pardo, MD



Hair Removal Diode



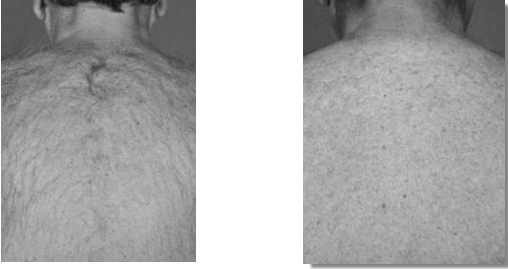
**Pseudofolliculitis Barbae
Diode**

Photos Courtesy of Fran E. Cook-Bolden, MD



After 2 elōs Hair Removal Treatments
Courtesy of T. Maurico M.D.

After 6 elōs Hair Removal Treatments
Courtesy of R. Russo M.D



***Laser Hair Removal
Side Effects & Complications***

Hair Removal Side Effects

- Pain
 - Larger spot sizes associated with more pain
 - Pain tolerance decreases as length of treatment increases
 - Epidermal cooling very important in pain management
- Perifollicular edema and erythema
- Folliculitis

Laser Injury Occurrences

- Poor patient selection
- Inadequate understanding of light and tissue interaction
- Inadequate epidermal protection

Light Based Adverse Events

- Scarring
- Burn/blister
- Infection
- Hyperpigmentation
- Hypopigmentation

Scarring

Scarring caused by:

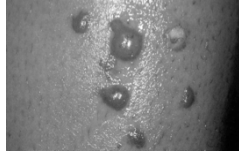
- Over aggressive treatment
- Inadequate cooling
- Post-procedural infection



Following treatment with Nd:YAG

Burns/Blistering

- Occurs in 10-15% of patients
- Due to direct thermal injury
- Lower fluences and larger spot sizes lead to greater chance of burns



Treatment using Diode laser

Narain CA and Ashier TS. A practical review of laser-assisted hair removal using diode, alexandrite, ruby, pulsed ruby, and long pulsed alexandrite lasers. Dermatol Surg 1995;21:1595-1602.

Hypopigmentation

- Dark skin types experience more hypopigmentation
- May be related to
 - Melanocyte destruction
 - Suppression of melanin production
 - Melanin redistribution



Treatment with Ruby laser

Goldberg, D.J. Complications in Cutaneous Laser Surgery. Taylor & Francis, 2004.

Hyperpigmentation

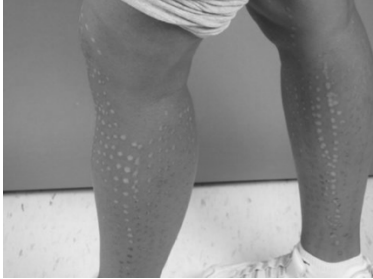
- Lighter skin types experience more hyperpigmentation
- May be related to:
 - Melanin stimulation
 - Delayed tanning
 - Epidermal injury
 - Photo-oxidation of existing melanin



Treated with Intense Pulsed Light

Goldberg, D.J. Complications in Cutaneous Laser Surgery. Taylor & Francis, 2004.

Poor Laser Choice



Poor Cooling/Excess Energy