Chapter 10
Laser Hair Removal

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Abstract Laser hair removal is one of the most common non-surgical procedures performed in the United States. Excessive, unwanted hair can be seen in all ages, ethnicities and skin types and lasers can help provide a permanent reduction in hair growth. Professional and home-based laser and light systems are both currently available, with professional systems including the 694 nm ruby laser, 755 nm Alexandrite laser, the 800 nm diode laser, the long-pulsed 1,064 nm Neodymium doped: yttrium aluminum garnet (Nd:YAG) laser, intense pulsed light (IPL), and radiofrequency. While generally safe, side effects from laser hair removal are possible and should only be used by trained medical professionals after performing a thorough history and physical examination. This chapter will provide a succinct approach to laser hair removal, including but not limited to available modalities, patient selection, reported side effects and management of care.

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Introduction

- Laser hair removal is one of the most common non-surgical procedures performed in the United States.
- Professional and home-based laser and light systems are both currently available. Professional laser and light systems for hair removal include the: 694 nm ruby laser, 755 nm Alexandrite laser, the 800 nm diode laser, the 1,064 nm Neodymium doped: yttrium aluminum garnet (Nd:YAG) laser, intense pulsed light (IPL), and radiofrequency. In the United States, home-based systems include only diode and IPL systems [1].
- Excessive, unwanted hair can be seen in all ages, ethnicities and skin types.
- Laser hair removal results in a permanent reduction in hair growth and not total permanent hair loss.
- A complete, but temporary hair loss can be seen for 1–3 months after treatment. Hair re-growth after laser hair removal may be finer and fairer, more closely resembling velus hair. This may change over time, ultimately appearing akin to terminal hair.
- Laser hair removal functions on the principle of selective photothermolysis, with melanin serving as the target chromophore [2]. This increases the incidence of side effects in patients with darker Fitzpatrick skin types.
- Laser hair removal of white, blonde or red hairs is generally ineffective due to decreased quantities of eumelanin (dark melanin) [3].
- Aside from general cosmesis, laser hair removal may also help to improve the untoward effects from conditions such as pseudofolliculitis barbae and acne keloidalis nuchae [4].
- Paradoxical hypertrichosis is an uncommon, yet possible side effect with a reported incidence between 0.05 and 10.2 % [5–8].

Background

Long-Pulsed 694 nm Ruby Laser

- The long-pulsed 694 nm Ruby laser is the oldest laser used for hair removal.
- In patients with fair skin and dark course hair, it is highly effective with few side effects [9].
- Due to its highly selective targeting of melanin, it is not recommended for patients with greater than Fitzpatrick type III skin or patients with recent sun exposure. For this reason, it has fallen out of favor.

755 nm Alexandrite Laser

- Synthetic alexandrite crystal is used to emit energy at 755 nm wavelength, corresponding to the middle of the melanin absorption spectrum.
- The 755 nm Alexandrite laser typically has a larger spot size and higher repetition rate than 694 nm Ruby laser.
- The longer wavelength of the 755 nm laser results in slightly deeper penetration and avoidance of epidermal melanin when compared to the long-pulsed 694 nm Ruby laser, yet is still not ideal for darker skin types.

800 nm Diode Laser

- Like the 755 nm Alexandrite, the 800 nm diode produces light in the middle of the melanin absorption spectrum, with greater depth penetration than the 694 nm Ruby and 755 nm Alexandrite lasers.
- It has been suggested that lower fluences with either longer pulse durations or higher repetition rates may help when treating ethnic skin in order to avoid epidermal damage, however it is not the wavelength of choice for darker skin [10].

1,064 nm Long-Pulsed Nd:YAG Laser

- The 1,064 nm Nd:YAG possesses the single deepest-penetrating wavelength of all the laser systems used for hair removal.
- When compared to other available wavelengths, due to its deeper penetration, as well as the fact that the 1,064 nm wavelength is on the tail end of the melanin absorption spectrum, it is more effective in bypassing epidermal melanin absorption.
- For this reason, this wavelength may cause fewer side effects when treating Fitzpatrick skin phenotypes IV–VI, but is generally less effective [11, 12].

IPL (515–1,200 nm)

- IPL systems emit broadband non-coherent light, targeting chromophores such as water and hemoglobin, in addition to melanin.
- Its larger spot size (120–450 mm^2) allows it to treat large areas such as the back or chest.
- Due to their broad emission spectrum, and thus decreased selectivity, efficacy and side effect rates may be extremely varied.
- Spectra may be tailored with the addition of optical filters [13].

Q-Switched Nd:YAG Lasers

- Q-switched, as opposed to long-pulsed, delivers energy through an aperture-like device, maximizing energy and peak power with a short pulse duration (nanosecond range).
- Efficacy for this form of delivery is varied as some authors suggest the pulse duration is too short to properly heat the target hair follicle [14]. Others report moderate efficacy

with high patient satisfaction [15, 16]. The long-pulsed Nd:YAG is nonetheless more commonly used.
- The Q-switched 1,064 nm Nd:YAG has also been shown to be effective in improving symptoms of pseudofolliculitis barbae [4].

Radiofrequency

- Radiofrequency devices do not specifically target melanin.
- They, however, have been studied in conjunction with IPL and diode lasers to increase effectiveness, particularly with difficult to treat fine or fair hairs [17, 18].
- One study found that the addition of aminolevulinic acid to radiofrequency/IPL hair removal increased efficacy in removal of white terminal hairs [19].

Indications

- Aesthetic removal/reduction of unsightly or unwanted hair.
- Medical conditions where excessive hair growth may be characteristic, or conditions where hair removal may improve course of disease.[1] These include:
  - Idiopathic hirsutism: male-pattern, androgen-dependent hair growth in women not secondary to any identifiable factor.
  - Local acquired hypertrichosis[2].
  - Pseudofolliculitis barbae.

[1]When evaluating for idiopathic hirsutism, it is important to rule out conditions in which increased hair growth may be a harbinger for more serious underlying conditions. These may include polycystic ovarian syndrome (PCOS), congenital andrenal hyperplasia (CAH), or malignancies (Table 10.1).
[2]Generalized secondary hypertrichosis, typically drug-induced, may resolve with removal of the inciting agent (Table 10.2).

- Laser hair removal has been shown to be most safe and effective in patients with fair skin and dark, course hair due to the ability for laser wavelengths to more selectively target melanin in the hair follicle.
- With proper wavelength, fluence, spot size and pulse duration selection, patients with Fitzpatrick skin types IV or greater may be treated with variable success.

Contraindications

- Unable to tolerate other forms of light therapy, such as:
  - Patients with seizure disorders triggered by light
  - Patients with lupus erythematosus
  - Patients who have received or are currently receiving gold therapy
  - Patients with a light sensitivity disorder
  - Patients taking medication that increases sensitivity to light
- Active local infections.
- Pregnant (effects on fetus are unknown).
- Patients with tattoos in the area to be treated should be advised that changes in tattoo color might occur.
- History of depilation within 2 weeks prior to treatment. Removal of the hair follicle prior to laser therapy may decrease effectiveness.

Procedural Technique/Considerations

Pre-op Care

- A full medical history should be obtained prior to the first laser hair removal session. This should include:
  - Current medications
  - History of recent sun exposure
  - Endocrine status
  - History of light insensitivity

  - Scarring tendencies
  - Recent hair removal methods that may have been performed as well as any side effects that may have been experienced with them

- Conditions and medications that may cause hirsutism or hypertrichosis can be found in Tables 10.1 and 10.2.
- Patient expectations should be discussed prior to treatment.
  - Laser hair removal has only been shown to result in the permanent reduction of hair quantity, not in permanent total hair loss (no matter how many sessions are performed).
  - While total hair loss may be seen for some weeks to months, hair re-growth is expected.
  - Hair loss may not occur immediately after treatment. It may take up to 2 weeks for affected hair to fall out.
  - Fair or velus hair that grows from treated areas may darken over time.

- Patients should be counseled to avoid plucking or electrolysis 4 weeks prior to treatment.
- Sun exposure to treated areas should be none to minimal beginning 6 weeks before the procedure to 6 weeks after the procedure, especially if at risk for hyperpigmentation.
- If there is a history of herpes simplex virus (HSV) outbreaks in the area to be treated, antiviral prophylaxis can be given for 1 week, started 2–3 days prior to laser treatment.
- A test spot may be performed in an area that is discrete, yet similar in skin color, sun exposure and hair density to the treated area.

  - Each setting should be tested with four, 10 % overlapping spots.
  - It may take 1–2 days to demonstrate side effects.
  - Erythema and perifollicular edema are expected (Fig. 10.1).
  - Intolerable pain, erythema and edema that last for longer than a few hours, blistering or crusting are all indications that fluence should be decreased.

Table 10.1 Conditions that may result in unwanted hair growth, hirsutism and hypertrichosis [20–22]

Underlying condition	Types	Associated symptoms	Possible sequelae
Hirsutism			
PCOS	n/a	Menstrual irregularities	Mood irregularities
		Male-pattern balding	Metabolic disorders
		Acne	Subfertility
		High serum androgens	
		Central obesity	
Ovarian hyperthecosis[a]	n/a	Same as above	Insulin resistance
		Post-menopausal	Cardiovascular disease
CAH	Non-classic (late-onset)	Premature pubarche	Subfertility
		Acne	
		Accelerated bone age	
		Menstrual irregularities	

Insulin resistance syndromes	Type A, Type B syndromes	Virilization	Acanthosis nigricans
		Amenorrhea	Subfertility
		Lipoatrophy/dystrophy	Other autoimmune disorders
Tumors	Adrenal	Virilization	Usually malignant
		Amenorrhea	
		Cushing's syndrome	
	Ovarian	Refractory hypertension	Usually malignant
		Hypokalemia	
		Abdominal pain	
		Palpable mass	
	Pituitary adenoma	Cushing's syndrome (disease)	

(continued)

Table 10.1 (continued)

Underlying condition	Types	Associated symptoms	Possible sequelae
Hypertrichosis			
Hypothyroidism	n/a	Course, dull scalp hair	Resolves with hormone replacement
		Pretibial myxedema	
Anorexia nervosa	n/a	Generalized lanugo	Malnutrition
			Electrolyte abnormalities
			Death
Porphyria	Cutaneous	Sensitivity to light	Hepatic fibrosis
			Cirrhosis
Dermatomyositis	Juvenile	Proximal muscle weakness with dermato®logic manifestations	Internal malignancies
		Pain	
Polymyositis	Adult-onset	Proximal muscle weakness	Blood and solid organ malignancies
			Interstitial lung disease

PCOS polycystic ovarian syndrome, *CAH* congenital adrenal hyperplasia
[a]Unclear if ovarian hyperthecosis is on the spectrum of disease for polycystic ovarian syndrome

Table 10.2 Agents that may result in hirsutism or hypertrichosis [20, 23]

Drugs that may cause unwanted hair growth	
Hirsutism	**Hypertrichosis**
Danazol	Phenytoin
Testosterone	Cyclosporine
Metyrapone	Penicillamine
Corticotropin	Diazoxide
Glucocorticoids	Minoxidil
	Psoralen
	Streptomycin
	Valproic acid

Technical Considerations

- Protective eyewear must always be used.
- Consult laser manual for specific fluences, spot sizes and pulse durations as these differ between laser systems. Many programs have pre-set parameters based on skin phenotype.
- Larger spot sizes may be more effective for hair removal at identical fluences [24].
- Hair in the treated area should be shaved or trimmed to avoid thermal damage from heat diffusion.
- A mild cooling spray or dynamic cooling device can be used to improve patient safety and comfort.
- Topical anesthetics may be used for patient comfort.

Post-op Care

- Wound care and/or dressings are typically not necessary following treatment.
- Arrange open lines of communication should any adverse events occur.
- Multiple laser treatments may be necessary to yield effective clinical results [25].

Figure 10.1 Expected erythema and perifollicular edema immediately after procedure

Complications

The reported incidence of complications following laser for hair removal is low, however side effects are more common in patients with Fitzpatrick skin types IV–VI due to competition with epidermal melanin.

- Expected side effects:
  - Pain (mild to moderate)
  - Erythema
  - Perifollicular edema

- Unwanted side effects:
  - Temporary dyspigmentation
  - Blistering
  - Crusting
  - Infection
  - Scarring
  - Hypertrichosis

Prevention and Management of Complications

- Topical anesthetics may be used. If pain is intolerable, however, strength may be too high.
- The risk of blistering and crusting, and thereafter infection and scarring are more common when treating patients with darker pigmentation or patients who have had recent sun exposure to the treated area [26]. Careful selection of wavelength, fluence and pulse duration can help minimize the risk of these effects [27]. Test spots may also help identify settings.
- The etiology of paradoxical hypertrichosis is unknown, yet it is thought to be related to sub-therapeutic dosing [28]. It is more common in Fitzpatrick skin types III and IV, particularly patients of Mediterranean or Pacific Asian descent, as well as patients with hirsutism [6, 7].
- Patients should be reassured regarding expected side effects of erythema and perifollicular edema.
- Physicians should always make themselves available to address any and all questions and concerns patients may have.

Conclusion

- Lasers and IPL are an effective means of reducing hair growth.
- Laser hair removal does not result in the total, permanent loss of hair.
- Treatment typically requires several sessions to maintain hair loss.

- Home-based systems are not as effective as professional systems.
- Future studies are needed to optimize laser hair removal of white, blonde, and red hairs.
- A highly effective and safe hair removal system for patients with deeply pigmented skin is still currently not available.

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