Introduction

Laser Hair Removal (LHR) is a method that involves the removal of hair by exposure to laser light pulses. These pulses help in destroying the hair follicles. Laser hair removal is extensively used and practiced in clinics, as well as homes using various devices with advanced technology devices. It beams highly concentrated light into hair follicles, resulting in the pigment in the follicles absorbing the light, thereby destroying it [1]. LHR applies to all types of skin.

The lasers are used to remove unwanted hair from the face, leg, chin, back, arm, underarm, bikini line, and other areas [2].

Benefits of LHR include:

1. Lasers can target dark, coarse hair specifically, leaving the surrounding skin undamaged.
2. It is a speedy process.
3. If patients want permanent hair loss, repeated LHR helps [2].

LHR is known for the significant delay in hair growth for long periods, not permanent hair loss. Initially, multiple laser hair removal treatments are required, followed by maintenance treatment. Laser hair removal is most useful for people having light skin and dark hair.

Factors that contribute to successful and effective removal include hair color and skin type. Here, we use the fundamental principle that involves pigmentation of the hair, which should absorb the light, but not the skin's pigmentation.

The laser used should damage only the hair follicle, leaving the skin unaffected. Therefore, a contrast like dark hair and light skin results in the best and precise outcomes.

The risk of skin damage is more astounding when the contrast between hair and skin color is small, but the recent advancement in technology has removed these barriers.

Laser hair removal is effective to a lesser extent for hair colors that do not absorb light well, such as gray, red, blond, and white. These are a few limitations of LHR.
Lasers used in Laser Hair Removal

- **Ruby hair removal laser**
  
The Ruby hair removal laser was the first system adopted for permanent hair removal. This system involves the use of a shorter wavelength of 694 nm targeting melanin, enabling ruby laser ideal for removing light and thin hair. On the contrary, this laser system is not used for darker skin tones. The advantage of this type of laser is that the Ruby laser system has a long pause between laser pulses, which aids in decreasing discomfort and is less painful comparatively. The repetition is slow, and thus ruby laser treatments require more time than other hair removal laser systems. The Ruby laser is an effective option for smaller treatment areas [3-5].

- **Alexandrite hair removal lasers:**
  
The Alexandrite laser is a popular fastest system for LHR. The Alexandrite laser operates at a wavelength of 755 nm, making it ideal for targeting the melanin in individuals’ hair follicles with light to olive skin tones. The laser can cover a large treatment area, such as the back, in a little time, i.e., less than 30 minutes. The repetition is quite painful (as the laser is typically used at a fast reputation rate) and hence considered one of the least comfortable LHR systems. The development of new devices having built-in cooling devices helps overcome problems and improve the patient experience. [3-5]

- **Diode hair removal lasers:**
  
Diode machines are newly developed approaches in the field of LHR. They contain an energy source consisting of semiconductors, known as diodes, grouped to create a laser beam with a longer wavelength of 800-810 nm, allowing deeper penetration into the hair follicle. Diode lasers are usually considered safe on darker skin types. They are exemplary for removing thick or coarse hair, thus making the Diode hair removal laser system popular among men to remove back hair or chest hair. [3-5]

- **Neodymium-doped yttrium aluminum garnet (Nd YAG) hair removal laser:**
  
Nd YAG laser machines produce two different types of light 1064 nm and 532 nm. Here, the 1064 nm wavelength targets the hair follicles far beneath the skin’s surface, and the 532 nm (unless frequency doubling is introduced in laser design) wavelength penetrates the follicles closer to the skin surface. At this 1064 nm wavelength, carbon is a better chromophore (a colored chemical compound that absorbs light) than melanin. Therefore, before treatment, a carbon lotion is applied to the skin allowing its absorption by the unwanted body hair. Since the laser targets the carbon instead of melanin, Nd-YAG laser is considered safe for all skin types, including tan skin tones. [3-5]

- **Intense pulsed light (IPL) hair removal**
  
IPL does not involve a laser, but the equivalent form of intense pulsed light like lasers. IPL initiates photo-thermolysis by pulsing thermal energy that is absorbed by the melanin in the hair follicle. The advantages of intense pulsed light are its customizable wavelength, energy level, and pulse duration. [3-5]

Complications related to Laser Hair Removal

**Immediate Complications:**

- **Burns**
  
Nowadays, burns from laser have become common. The burns occurred due to the laser is characterized into three types-

  1. The first-degree burns are not severe and do not require special treatment as it usually heals with time.
  2. The second and third-degree may result in blistering, pigmentation, and scarring of the skin [6].

- **Blistering**
  
Blistering is a result of a second-degree burn. This occurs due to the inexperienced or unqualifies technicians performing the laser therapy. Blisters are excruciating and may cause discomfort. If left untreated, they may lead to scarring and pigmentation changes [6].

- **Hyperpigmentation**
  
Hyperpigmentation is the term referred to the darkening of the skin. It usually fades within three months but can also last as long as six to eight months. It is generally observed in patients.
with darker skin and is treated with excessive laser energies or epidermal cooling [6].

**Hypopigmentation**

Hypopigmentation is the lightening of the skin that occurs when the laser beam is absorbed by the skin partially rather than absorption by hair follicles. The beam disturbs or leads to an imbalance of melanin production. This can last up to two months but can be permanent in severe cases [6].

**Scarring**

Scarring is usually a complication related to laser burns. Improper use of laser machines usually leads to scarring [6].

**Crusting**

At times, laser irritates the hair follicles leading to slight bleeding or scab formation. It usually occurs in people who have ingrown hairs. The primary reason for crusting is laser overtreatment [6].

**Palpable Purpura**

Purpura is referred to as bleeding under the skin that causes purple spots or rashes. Purpura is temporary and usually heals and disappears in 3-5 days. It is a usual complication of tanned skin; therefore, it is not advised to get laser removal on tanned skin [6].

**Skin Irritation or Erythema**

Laser removal usually causes temporary irritation with slight swelling and redness in the treated area. This usually disappears within a few hours or on the application of ice packs [7] (FIGURE 1).

**Late Complications:**

**Folliculitis**

Folliculitis is an inflammation of hair follicles. It is presented with red pimples with hair in the center of each one. These pimples may have pus in them, causing itching & burning of the skin. It is a common complication in males undergoing laser removal [8,9].

**Contact Dermatitis**

Contact dermatitis is a type of inflammation that appears as redness, swelling, itching, and occasional blisters causing discomfort. This is a usual complication with the face and feet. Dermatitis heals within a day of treatment unless it is not scratched or bought into contact with chemicals.

**Paradoxical Hypertrichosis**

Paradoxical hypertrichosis is an uncommon condition (0.6%-10%), but certainly found common in few ethnic groups and anatomic regions like Asian, and the Mediterranean. Paradoxical hypertrichosis commonly occurs on the face and neck. The individual with the darker skin tone is at a higher risk. The pathogenesis of paradoxical hypertrichosis is widely unknown [9,10].

**Fox Fordyce**

Fox Fordyce is a sporadic inflammatory disease of apocrine sweat glands, followed by laser hair removal. Laser removal is the primary cause of auxiliary fox Fordyce. The laser is said to damage the follicular infundibulum leading to epidermal detachment and delayed keratinocyte

![FIGURE 1. Immediate complications of Laser Hair Removal.](image-url)
maturation. It is characterized by pruritic skin-colored follicular papules appearing on gland-bearing areas [11].

**Leukotrichia**

Leukotrichia is a scientific term for white hair. The common complication is caused due to excessive absorption of the laser beam by hair follicles resulting in the reduction or absence of melanin by the destruction of the melanocyte. It may be temporary or permanent.

**Hyperhidrosis and Bromhidrosis**

Bromhidrosis is a foul-smelling body odor caused by the sweat that encounters bacteria on the skin resulting in the release of smell. The strategy behind this is colonization by odor-producing bacteria in the hairs. With hair removal, the bacteria start colonizing the skin, resulting in a changed flora of skin presented with an increased odor [12].

Hyperhidrosis is abnormally excessive sweating. Avoid exercise and hot showers for at least 24 hours after laser removal, as this could lead to infection or ingrown hairs [13] (FIGURE 2).

**Ocular Complications**

Lasers can cause reversible and irreversible damage to the eye. Various cases of uveitis, iritis, and iris atrophy have been reported after laser procedures. Ocular complications are caused due to the penetration of laser into different layers of eyes damaging the area being exposed. Therefore, the use of protective equipment is encouraged and recommended [13].

**Equipment related Hazards:**

Laser devices are powerful tools that are equipped for various indications, but these are also harmful to patients in many ways. Trained professionals should practice laser hair removal as the equipment is quite complicated, and the lasers can damage the skin.

The handling of this equipment presents an important task for the professional as he is responsible for preventing complications related to the equipment. The persons in the laser rooms should wear all protective safety equipment to avoid damage due to the laser. There should be controlled access, proper use of protective devices, monitoring of testing of laser operations.

**Laser Safety**

**Preventing fires**

- Overheating of the room should be avoided.
- The presence of oxygen cylinders or open oxygen outlets should be handled with utmost care.
- The use of alcohol-based cleansers should be avoided.
- Electrical hazards are to be avoided
- Hair bearing areas not undergoing laser therapy should be covered with a moistened gauze.
- When not in use, the laser should be kept in standby mode.

![FIGURE 2. Late complications of laser hair removal [14].](image-url)
• Controlled people should access laser rooms.
• No use of reflective material in the laser room, and the patients should be asked to remove any metallic chains or ornaments before the procedure.
• In case of emergencies, there should be easy access to the emergency switch-off button [13].

**Personnel safety**

• Eye protection is compulsory in the controlled access area for patients as well as physicians.
• The protection should be as per the recommendation of the device manufacturer [15].

### Preventive measures to prevent complications

It is important to know that certain precautions should be kept in view while undergoing Laser Hair Removal. There is an advantage that if one follows these, the best results are achieved. While the disadvantage is that avoiding things may lead to various complications following the procedure. In 1983 Parrish and Anderson suggested the theory of selective photothermolysis. As per Parrish and Anderson wavelength should be completely absorbed by the chromophore in the targeted tissue and should not be absorbed by the surrounding tissue therefore, laser should be delivered in a pulse duration which is equal or less than the thermal relaxation time or TRT (time required by an object to cool down by 50%). If the delivery time exceeds thermal relaxation time, then the energy gets dissipated to the nearby tissue, resulting in tissue damage. Not only TRT but fluence also play a critical role in tissue damage. Fluence reaching the target tissue must be equal or exceed the threshold fluence to result in tissue damage. The same can be managed by controlling two different parameters, which is wavelength and pulse duration [16].

Wavelength: after selecting the chromophore's proper wavelength, the practitioner should deliver the maximum number of photons to the targeted chromophore. This can be done effectively by altering pulse duration and fluence [17].

Pulse duration: to avoid thermal injury to the epidermis, a pulse duration of longer than 10 ms must be considered. For follicle damage, pulse duration must be larger than the follicle cooling time, i.e., 100 ms. By combining these two concepts, the ideal pulse duration must be between 10 ms-100 ms.

**Other than above, some of the common general preventive measures are:**

• The areas where you want to get the hair removal done should not be tanned. This is advised as tanning can have an impact on the effectiveness of the treatment.
• Plucking, bleaching, or waxing should be avoided three weeks prior to the treatment. This is so advised because preserving the root and the pigment of hair is important for laser removal success.
• Make sure to shave the area you want to get hair removal done a day or night before the treatment.
• Wash the area being treated completely and thoroughly to remove any kind of oil present on the skin before undergoing the treatment.
• Moisturize the area well before and after the laser for a smooth and better response [18] (TABLE 1).

### Management of complications:

Laser procedures are performed with great precautions as they are emerging as major cosmetic procedures. Laser Hair removal usually leads to one or the other complication but managing them is an easy task.

• Topical corticosteroid creams may help to minimize the erythema and edema.
• Antibiotic ointment may be prescribed if the epidermal injury is observed.
• Patients are advised to avoid sun exposure.
• Most patients have a mild sunburn-type sensation post-treatment that eventually fades in 2-3 hours. Moisturizers and/or cool compresses can be useful at this time.
• In case of blisters, small blister areas can be treated with Bacitracin TID until they heal.
• Depigmentation therapy was recommended for a few patients.
• In case of paradoxical growth, hormone pathologies are tested before prescribing.
Eflornithine is used in a few cases, but no significant improvement is noticed (TABLE 2).

### The cooling device in laser therapy

In some cases, during laser hair removal, tissue injuries occur. Dark skin tone patients are more susceptible to tissue injury during laser hair removal due to the presence of a high amount of melanin. Melanin absorbs energy from the laser, which results in heat generation [19]. Hence proper measures should be considered to prevent tissue injuries, which are as follow:

- **Ice-cube cooling:** It is one of the most simple and easy to use method. The ice cube method is suitable for all kind of laser therapy. The ice pack is wrapped in a soft cloth and applied for about 15 minutes or until the burning sensation exists. Nowadays, it is commonly used in hair removal, wine stains and leg telangiectasia [20].

  **Sapphire tip cooling:** it can be used before, during, and after the laser therapy. It is commonly used when treatment is with a longer pulse duration (generally more than 10 ms). The Sapphire tip cooling method is easy to use but its application is limited due to its cost [21,22].

  **Cryogen spray:** it was the first cooling spray with liquid nitrogen used at a distance of around 20 cm from the skin. However, it is not used nowadays as it can result in cryonecrosis.

  **Dynamic cooling device:** it is a new cooling device integrated with a laser machine and uses cryogen spray (nontoxic 1,1,1,2-tetrafluoroethane or R-134a). Cryogen is sprayed just before the laser pulse and causes selective cooling (200 um of superficial tissue) [23]. It is commonly used when the pulse duration is less than 5 ms.

  **Zimmer:** it can be used before, during, and after laser treatment. Without interfering, Zimmer...
cools down the epidermis, and it can be used with any laser device. Zimmer delivers chilled air in the entire procedure and also ensure patient and physician comfort during the procedure. Commonly used during tattoo removal, hair removal, port-wine stain, and other vascular lesions [24].

However, Zimmer was reported to have an increased incidence of post-inflammatory hyperpigmentation [25].

**Conclusion**

Laser Hair Removal is a commonly used cosmetic procedure to remove unwanted hair. The principle behind Laser removal is Selective Photo thermolysis. The lasers are equipped with cooling sources like cryogen spray, contact cooling, and air cooling to prevent laser heating complications. The laser therapy mainly depends on the enumerable factors like hair color, skin color, the sensitivity of the skin, type of equipment used, etc. Complications related to lasers are widespread and can be treated with minimal care. Burns, scarring, urticaria, etc. are the conditions noticed immediately after the laser removal. Folliculitis, fox Fordyce and a few are observed after some duration of the therapy. All the complications can be prevented using preventive measures followed precisely, and treatment will be provided based on particular complications. The awareness about preventive measures and safe removal practices should be clearly delivered to the patient. The practice of preventive and safe methods provides a base for future outlooks, requiring attention and consideration so that effective measures can be developed to prevent the complications related to laser hair removal.

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Different hair removal lasers part. [Available at: https://www.skinnymedspa.com/different-hair-removal-lasers-part-i/]


Laser hair removal pre and post treatment care. [Available at: https://www.simplicitylaser.com/pages/laser-hair-removal-pre-post-treatment-care].


