

Laser hair removal -Mechanisms and complications



Abstract

This review provides a study of the complications related to Laser Hair Removal (LHR) along with the complication management pertaining to laser hair removal therapy. Laser hair removal is a widely practiced cosmetic procedure that is considered safe and effective. Comparatively, it is more effective than shaving, waxing, plucking, and epilation in terms of pain, speed, accuracy, and many other factors. Nevertheless, it also has complications like any other procedure. The complications associated with LHR could be immediate or, it might take some time to occur, which depends on various factors. Most of the complications can be prevented by the healthcare provider, while others can be treated with minimal medications. Alongside managing these complications, pre-treatment and post-treatment care must be precisely followed for effective results. The management therapy includes the use of corticosteroids, topical analgesics, selective antiviral agents, emollients, moisturizing creams, and lotions as the aftercare of the procedure and some other agents depending on the type of complication observed in a patient. Hence, there is a broad scope for laser hair removal advancements to avoid complications and achieve the best results.

Keywords: laser hair removal, cosmetic procedures, complications of laser hair removal, burns by laser hair removal, prevention of complications by laser hair removal

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.

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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 repetition 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 system is the advanced system in cosmetic laser technology. It offers an effective hair removal system along with its numerous applications, including tattoo removal, laser skin resurfacing, and the correction of sun damage.

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 unqualified 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 over-treatment [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 brought into contact with chemicals.

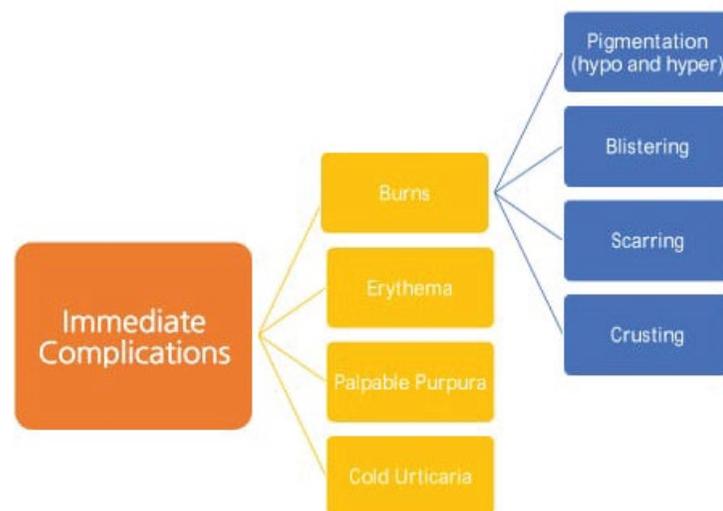
Paradoxical Hypertrichosis

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.



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].

- 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.

TABLE 1. Pre-treatment care and post-treatment care in laser hair removal procedure [18].

Pre-treatment	Post-treatment
The area should be clean shaved prior to treatment.	Avoid extended UV exposure for seven days after the treatment.
UV exposure should be avoided seven days prior to the treatment.	In case of blisters, do not puncture them.
If any person is sunburned or tanned, they should wait for two weeks before scheduling the treatment.	If there is broken skin, an antibiotic ointment should be used until complete healing is achieved.
Exfoliation of the area is recommended.	Exfoliate treated areas in order to minimize the risk of ingrown hairs.
If possible, the numbing creams should be applied 30 to 40 mins prior to the treatment, but it should be cleaned before going for treatment.	Use of Gel, cool towels, ice packs, or aloe vera should be recommended to prevent discomfort due to heat.
If a person has a history of cold sores, it is recommended to take an antiviral medication prior.	No chemical procedures or laser treatment should be advised two weeks after the treatment.
Antibiotics have the ability to increase photosensitivity. So, it is advised to check with a physician if long term antibiotics have been prescribed to them. In case they should be stopped seven days prior to treatment.	In case of repetitive therapy, follow-up for each session is important.

TABLE 2. Management of complications.

Complication	Treatment
Burning	Topical steroid plus antibiotic
	Preventive (use of epidermal-cooling devices)
Scarring	Preventive only (laser's parameters should be adjusted and use of epidermal-cooling devices)
Pigmentary changes	Topical steroid
	Preventive (adjust laser's parameters, avoid sun exposure)
Post-treatment erythema and edema, Reticulate erythema	Topical steroid
Ocular complications	Specific to each complication
Pain	Epidermal-cooling devices
	Topical anesthetic
Purpura	Preventive only (adjust laser's parameters)

- 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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References

- Laser Hair Removal. [Available from: <https://www.cntaacclinic.ca/laser-hair-removal>]
- Laser Hair Removal. [Available from: <https://www.webmd.com/beauty/laser-hair-removal#1>]
- Haedersdal M, Wulf HC. Evidence-based review of hair removal using lasers and light sources. *J Eur Acad Dermatol Venereol*. 20: 9-20 (2006).
- Liew SH. Laser Hair Removal. *Am J Clin Dermatol*. 3: 107-115 (2002).
- Different hair removal lasers part. [Available at: <https://www.skinneymedspa.com/different-hair-removal-lasers-part-i/>]
- Chandrashekar BS, Shenoy C, Madura C. Complications of laser and light-based devices therapy in patients with skin of color. *Indian J Dermatol Venereol Leprol*. 85: 24-31 (2019).
- What are the rare risks, side effects, complications of laser hair removal. [Available from: <http://oksociety.in/2019/07/what-are-the-rare-risks-side-effects-complications-of-laser-hair-removal/>]
- Lapidoth M, Shafirstein G, Amitai DB, et al. Reticulate erythema following diode laser-assisted hair removal: a new side effect of a common procedure. *J Am Acad Dermatol*. 51: 774-777 (2004).
- Aleem S, Majid I. Unconventional uses of laser hair removal: A review. *J Cutan Aesthet Surg*. 12: 8-16 (2019).
- Gabriel CV, Cristiana V, Elena B, et al. Complications of laser hair removal-How we could reduce them?. *Dermatol Ther*. 33: e13518 (2020).
- Desai S, Mahmoud B, Bhatia A, et al. Paradoxical hypertrichosis after laser therapy: A review. *Dermatol Surg*. 36: 291-298 (2010).
- Elisa RT, Caterina F, Angela BM, et al. Axillary fox-fordyce disease induced by laser hair removal. *J Dermatol Res Ther*. 5: 071 (2019).
- Vasconcelos R, Sanches JA. Axillary hyperhidrosis and bromhidrosis: The dermatologist's point of view. *Hyperhidrosis*. 89-94 (2018).
- Laser hair removal: Strategies, types and uses. [Available from: <https://nursinganswers.net/essays/laser-hair-removal-strategies-types-7161.php>].
- Laser hair removal pre and post treatment care. [Available at: <https://www.simplicitylaser.com/pages/laser-hair-removal-pre-post-treatment-care>].
- Anderson RR, Parrish JA. Selective photothermolysis: Precise microsurgery by selective absorption of pulsed radiation. *Science*. 220: 524-527 (1983).
- Boulnois JL. Photophysical processes in recent medical laser developments: A review. *Med Sci*. 1: 47-66 (1986).
- Vano-Galvan S, Jaen P. Complications of nonphysician-supervised laser hair removal: case report and literature review. *Can Fam Physician*. 55: 50-52 (2009).
- Nelson JS, Majaron B, Kelly KM. Active skin cooling in conjunction with laser dermatologic surgery. *Semin Cutan Med Surg*. 19: 253-266 (2000).
- Adamic M, Troilius A, Adatto M, et al. Vascular lasers and IPLS: Guidelines for care from the European Society for Laser Dermatology (ESLD). *J Cosmet Laser Ther*. 9: 113-124 (2007).
- Zenzie HH, Altshuler GB, Smirnov MZ, et al. Evaluation of cooling methods for laser dermatology. *Lasers Surg Med*. 26: 130-144 (2000).
- Goldman MP. Lasers and Energy Devices for the Skin. 2nd Ed. Boca Raton: CRC Press. 100 (2013).
- Srinivas CR, Kumaresan M. Lasers for vascular lesions: Standard guidelines of care. *Indian J Dermatol Venereol Leprol*. 77: 3490-3468 (2011).
- Raulin C, Greve B, Hammes S. Cold air in laser therapy: First experiences with a new cooling system. *Lasers Surg Med*. 27: 404-410 (2000).
- Manuskiatti W, Eimpunth S, Wanitphakdeedecha R. Effect of cold air cooling on the incidence of postinflammatory hyperpigmentation after Q-switched Nd: YAG laser treatment of acquired bilateral nevus of Ota like macules. *Arch Dermatol*. 143: 1139-1143 (2007).