

# Comparative Study of Diode Laser Versus Neodymium-Yttrium Aluminum: Garnet Laser Versus Intense Pulsed Light for the Treatment of Hirsutism

Neerja Puri

Department of Dermatology, Punjab Health Systems Corporation, Punjab, India

Address for correspondence: Dr. Neerja Puri, House No. 626, Phase II, Urban Estate, Dugri Road, Ludhiana, Punjab, India.

E-mail: neerjaashu@rediffmail.com

## ABSTRACT

**Introduction:** Lasers are widely used for the treatment of hirsutism. But the choice of the right laser for the right skin type is very important. Before starting with laser therapy, it is important to assess the skin type, the fluence, the pulse duration and the type of laser to be used. **Aims:** To compare the efficacy and side effects of Diode laser, Neodymium-yttrium aluminum — garnet (Nd: YAG) laser and intense pulsed light (IPL) on 30 female patients of hirsutism. **Materials and Methods:** Thirty female patients with hirsutism were selected for a randomised controlled study. The patients were divided into three groups of 10 patients each. In group I patients diode laser was used, in group II patients long pulsed Nd: YAG laser was used and in group III, IPL was used. The patients were evaluated and result graded according to a 4-point scale as excellent, >75% reduction; good, 50-75% reduction; fair, 25-50% reduction; and poor, <25% reduction in hair density. **Results:** It was seen that the percentage of hair reduction after two sessions of treatment was maximum (40%) in the diode laser group, followed by 35% hair reduction in the Nd: Yag laser group and 10% hair reduction in the IPL group. The percentage of hair reduction after four sessions of treatment was maximum (64%) in the diode laser group, followed by 62% hair reduction in the Nd: Yag laser group and 48% hair reduction in the IPL group. The percentage of hair reduction after eight sessions of treatment was maximum (92%) in the diode laser group, followed by 90% hair reduction in the Nd: YAG group and 70% hair reduction in the IPL group. **Conclusions:** To conclude for the Indian skin with dark hairs, the diode laser still stands the test of time. But, since the diode laser has a narrow margin of safety, proper pre and post-procedure cooling is recommended. Although, the side effects of Nd: YAG laser are less as compared to the diode laser, it is less efficacious as compared to the diode laser.

**KEYWORDS:** Hirsutism, Darker skin, Diode laser, IPL, Nd: YAG laser

## INTRODUCTION

Hirsutism is a very common and psychologically distressing problem. Laser hair reduction is an important modality to treat hirsutism.<sup>[1]</sup> Permanent hair reduction is defined as a significant reduction in the number of terminal hairs at a given body site that is stable for a period of time longer than the follicles' complete growth cycle. There are three basic types of hair on the human body which differ in colour, texture and diameter. Vellus hair is the very fine, short, non-pigmented hair with a

small cross-sectional area. Terminal hair is the coarse, long, pigmented hair with a large cross-sectional area whereas intermediate hair is the hair that is intermediate in length and shaft size.

During laser hair removal, a laser beam passes through the skin to an individual hair follicle.<sup>[2]</sup> The intense heat of the laser damages the hair follicle, resulting in reduction of the number of hairs and the quality of hair.<sup>[3,4]</sup> Hair will be less noticeable, finer and possibly lighter. The degree of hair reduction depends on the number of treatments. Laser hair removal focuses on the endogenous chromophore melanin, which is mainly found in the hair shaft, with a small amount present in the upper third of the follicular epithelium. When an appropriate energy source such as a laser is directed at the skin, light is primarily absorbed in the hair shaft melanin. Hair removal lasers generally work on the principle of

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DOI:  
10.4103/0974-2077.158445

selective photothermolysis, based on selective absorption of laser energy by the components of the hair follicle. The target chromophore is melanin contained by the follicle, which has a broad absorption spectrum. Wavelengths between 700 and 1000 nanometers (nm) are selectively absorbed by melanin; the competing chromophores (oxyhaemoglobin and water) absorb less energy at these wavelengths.<sup>[5-8]</sup> The following are the types of lasers for hair reduction:<sup>[9,10]</sup>

- The diode laser is most effective for darker terminal hair and is less effective on lighter, finer hair. It covers large areas and has fast repetition rates, allowing brisk treatment of large body areas.
- The long pulse Neodymium-yttrium aluminum – garnet laser (Nd:YAG laser) can be safely used in all skin types, including tanned patients. Large coverage areas and fast repetition rates allow large areas to be treated quickly. It causes more discomfort during treatment. It is also less effective for fine and light hair than other lasers.
- Intense pulsed light (IPL) devices are not lasers, but are “laser equivalents” in the sense that they use the same concept of selective photothermolysis to accomplish hair removal. IPL devices are more difficult to use than lasers and require a very skilled and experienced technician to operate.
- Long Pulsed Alexandrite 755-nm laser is also used worldwide. It is an effective laser with more depth of penetration in comparison to IPL and Nd: YAG lasers. It exerts effect on the hair follicle by applying the principle of selective photothermolysis.

### Aims

To compare the efficacy and side effects of Diode laser, Nd: YAG laser and IPL on 30 female patients of hirsutism.

### MATERIALS AND METHODS

Thirty female patients of hirsutism with skin type III - V were included in the randomised controlled study. Written informed consent was taken in all the patients before the study. Prior permission of the hospital ethical committee was taken before the start of the study. The patients were divided into three groups of 10 patients each. In group I patients, diode laser was used, in group II patients long-pulsed Nd: YAG laser was used and in group III, IPL was used. Pretreatment photographs were taken before the start of the treatment. The laser treatment sessions were performed at four weekly intervals and a total of eight laser sessions were performed. The follow-up of the patients was done every 3 months upto 1 year. The area assessed for comparative evaluation was the beard (chin) area. Detailed history, hormonal assay and abdomino-pelvic ultrasonography were performed to differentiate between idiopathic and pathological

hirsutism. Hair thickness and rate of hair reduction and re-growth were recorded by using hair counts and photographs before treatment and then once in every 3 months. Continuous chilled air flow was delivered during the procedure to provide maximum epidermal cooling and to make treatment painless for the patient. Fluence was determined, prior to the initial treatment session, by the maximum fluence tolerated according to the patient pain threshold and by the minimal resulting erythematous reaction, without any evidence of burn.



Figure 1: Pre and post-treatment photograph of a 26-year-old female after eight sessions of diode laser



Figure 2: Pre and post-treatment photograph of a 28-year-old female after eight sessions of Nd: YAG laser



Figure 3: Pre and post-treatment of a 21-year-old female after eight sessions of IPL

Ice packs were applied to the skin surface few seconds before and after treatment. The starting fluence and pulse duration were determined according to the skin type. Fluence was increased by 10% at each treatment visit if no side effects were noted from the previous session. The three groups were compared for efficacy and safety at the end of treatment. Efficacy was graded according to a 4-point scale from excellent to poor. Post-operative care for all patients included applying ice directly following laser sessions for a few minutes, sun avoidance, prophylactic topical antibiotics and sunscreen cream. All patients were instructed to leave their hair unshaved 10 days prior to treatment and to stop hair-removal methods apart from shaving or using depilatory cream between sessions. The primary outcome measure was the percentage of hair reduction, defined as the percentage of each difference with respect to the initial hair count. After each treatment and then at the end of six treatments, patients were evaluated and result graded according to a 4-point scale as excellent, >75% reduction; good, 50-75% reduction; fair, 25-50% reduction; and poor, <25% reduction in hair density.

A scoring system was devised for the purpose of standardising the selection of pulse duration and fluence and for assessing the efficacy of laser hair reduction:

Grade 1: Fine vellus hair.

Grade 2: Light brown, fine, low-density hair (intermediate hair).

Grade 3: Dark brown, less coarse, low-density (terminal hair).

Grade 4: Dark coarse, high-density hair.

While tabulating the results, Grade 2 was referred to as intermediate hair, Grades 3 and 4 were considered together as terminal hair. The inclusion criteria were grades 2, 3, or 4 type of hair with skin types IV or V.

### Exclusion criteria

The following patients were excluded from our study:

- Grade 1 hair.
- Any previous laser treatment to the study area.
- Any gross hormonal dysfunction, waxing, depilation, electrolysis or bleach use within six weeks of entry into the study.
- A history of keloid scarring.
- Pregnancy.
- Immunosuppression.

### RESULTS

The data was tabulated and the results were analyzed statistically using Chi-square test. Regarding the age distribution of the patients, it was seen that maximum (50%) patients were between 21 and 30 years of age, 30% patients were between 31 and 40 years and 10% patients

were between 10 and 20 years and 41 and 50 years, respectively. It was seen that there were 10% patients with grade 2 (intermediate) hairs, 30% patients had grade 3 (terminal) hairs and 60% patients had grade 4 (very coarse) hairs. It was observed that the percentage of hair reduction was maximum in the diode laser group, followed by Nd: YAG laser group. But the difference in hair reduction in both group I and group II was not statistically significant ( $P < 0.005$ ). But the difference in hair reduction in group I and III was statistically significant ( $P > 0.005$ ). It was seen that the percentage of hair reduction after two sessions of treatment was maximum (40%) in the diode laser group, followed by 35% hair reduction in the Nd: YAG laser group and 10% hair reduction in the IPL group. The percentage of hair reduction after four sessions of treatment was maximum (64%) in the diode laser group, followed by 62% hair reduction in the Nd: YAG laser group and 48% hair reduction in the IPL group. The percentage of hair reduction after eight sessions of treatment was maximum (92%) in the diode laser group, followed by 90% hair reduction in the Nd: YAG laser group and 70% hair reduction in the IPL group [Figures 1-3].

Side effects were comparable in all the three groups. Except pain experienced during the procedure. It was minimal in the IPL group and maximum in the Nd: YAG laser group. Pain as a side effect was seen in three patients in diode group, nine patients in Nd: YAG group and one patient in IPL group. Erythema was seen as a side effect in two patients in diode group, four patients in Nd: YAG group and two patients in IPL group.

Blistering was seen in none of the patients in diode group, one patient in Nd: YAG group and one patient in IPL group. Post-inflammatory hyperpigmentation (PIH) was seen in three patients in diode group, two patients in NdYag group and three patients in IPL group. It was seen that out of 30 female patients, 15% patients had hormonal disturbances in the form of polycystic ovarian disease.

### DISCUSSION

Multiple sessions undoubtedly yield more effective results in hair reduction in hair reduction because lasers can only target the anagen or active phase of the hair growth cycle.<sup>[11,12]</sup> At any given time, only 50-65% of facial hair are in the anagen phase for a duration of 3-4 weeks. Therefore, even if 100% of all anagen hairs are destroyed after each treatment, only a percentage of the total hair would be eliminated. The same holds true for each successive treatment and hence, multiple treatments are required to achieve the best case scenario.

Melanin content and pulse duration are two important criteria for achieving effective hair reduction with lasers.

Effective hair reduction is possible if the melanin within the hair shaft, hair follicle epithelium, and the heavily pigmented matrix, and also the stem cells in the area of the bulge, are targeted. Only lasers with wavelengths ranging from 630 to 1100 nm can irradiate the entire length of anagen hair extending 2-5 mm into the dermis. In addition, pulse duration serves as an important parameter for effective photoepilation which should be shorter than or equal to the thermal relaxation time (TRT) of the hair shaft. Both melanin content and TRT increase as the diameter of the hair shaft increases. A terminal hair has an average diameter of 60-80  $\mu\text{m}$ . Vellus hairs are  $<40 \mu\text{m}$  in diameter and contain little melanin, while the intermediate hair would fall somewhere in between. Therefore, for intermediate or finer hair, a shorter TRT would be required which is not fully safe in darker skin, as it might be insufficient for an optimum cooling of the epidermis. In such a scenario, it is quite understandable that it is far easier and safer to remove a terminal hair than an intermediate hair, and even less so, a vellus hair. This is one of the reasons that most laser hair reduction studies have been performed on dark terminal hair only. The response to laser hair reduction varies depending on the type of hair. Dark, coarse terminal hair respond better than fine, low-density intermediate hair.

The diode laser systems (800-810 nm), the long-pulsed Nd:YAG lasers (1064 nm) and IPL systems, a nonlaser light source, have evolved steadily over this period and, today, remain one of the most common and dependable epilation modalities available. Diode lasers are solid-state laser devices that have been very well received over the past several years because of their reliability and their ability to penetrate even deeper into the skin, thus, allowing even darker and perhaps tanned individuals to be successfully treated for epilation of unwanted hair.<sup>[13,14]</sup> In a study by Nadia *et al.*, a comparative study was done of different type of lasers and it was seen that best results were obtained with diode laser followed by alexandrite laser.<sup>[15]</sup> These devices also use sophisticated cooling apparatus, thus, assuring increased safety for our patients.<sup>[16]</sup> The most popular of the diode laser systems for hair removal is the LightSheer produced by Lumenis, Santa Clara, CA. This is an 810-nm diode laser with pulse widths that vary from 5 up to a newly introduced model, up to 400 milliseconds, allowing darker skin types to be easily treated. The spot size is  $12 \times 12 \text{ mm}$ , and it uses a fast repetition rate of 2 Hz, as well as fluences between 10 and  $60 \text{ J/cm}^2$ . It has its own contact cooling device known as ChillTip in its stand-alone version and Sapphire Cooled Tip in the Lumenis One model. The better results obtained with the diode laser may had been enhanced partly by the cooling effect of the integrated sapphire and the pressure exerted by it on the skin. Sapphire is ideal, as it has excellent thermal characteristics and operates as a heat sink removing heat from the epidermis. This

enables the target structures to be heated more efficiently, so that less fluences are required, resulting in less thermal load on the epidermis.<sup>[17]</sup>

The long pulsed Nd:YAG is the safest laser for hair removal in darker skin types. Two factors contribute to the safety of the long pulsed Nd:YAG in darker skin types. First, the wavelength of the Nd:YAG (1064 nm) is at the end of the absorption spectrum of melanin. This wavelength is sufficient to achieve significant thermal injury in dark coarse hairs while sparing epidermal pigment.<sup>[18-21]</sup> Secondly, the adjustable pulse width of long pulsed Nd:YAG lasers allows the laser energy to be delivered over a longer period of time allowing for the heat to dissipate and sufficient epidermal cooling to occur.<sup>[22,23]</sup> The long-pulsed Nd:YAG lasers are receiving the most attention at this time, and numerous systems are available using this long wavelength of light. At this wavelength of light, melanin absorption is reduced, which require higher fluences (power) to damage the hair effectively.<sup>[24]</sup> Epidermal cooling devices incorporated into these devices ensure a reduction in the potential for epidermal injury and allow them to be successfully used in patients with dark skin (up to skin type VI).

IPL is far less effective for laser hair reduction. The energy is produced by a lamp, a little like a light bulb, that produces a variety of light waves, meaning that it is more diffuse and less powerful. It is usually limited to use on fairer skin types.<sup>[25]</sup> IPL devices also offer sophisticated, computer driven precision and tremendous versatility, the key benefit of IPL system is its cost-effectiveness.<sup>[26]</sup> Larger treatment areas can be easily treated because of larger spot size. In a study by Shroeter *et al.*, 40 patients with excessive facial hairs, patients receiving an average six treatment sessions showed hair reduction by 76.7%.<sup>[27]</sup>

In a comparative study on hair reduction, the mean hair count reduction achieved by the diode laser, IPL and IPL+RF was 49.90%, 39.16% and 47.15%, respectively.<sup>[28]</sup> This study did not show any serious side effects and the number of side effects was minimal.

The two wavelengths which can safely be used for laser hair reduction on darker skin types are the diode (810 nm) and Nd:YAG (1064 nm). In terms of efficacy, the shorter wavelength (diode) laser is generally regarded as more effective because of 'melanin's higher absorption value which decreases with increasing wavelength.<sup>[29,30]</sup> However, the longer wavelength Nd:YAG laser is considered ideal for treating patients with darker skin, due to reduced scatter and deeper penetration of the laser light. Also, shorter pulse durations can be more safely used with the Nd:YAG laser than with the diode. This is an additional

advantage when dealing with finer hair with shorter thermal relaxation time (TRT).

## CONCLUSIONS

To conclude for the Indian skin with dark hairs, the diode laser still stands the test of time. But, since the diode laser has a narrow margin of safety, proper pre and post-procedure cooling is recommended. Although, the side effects of Nd:YAG laser are less as compared to the diode laser, it is less efficacious as compared to the diode laser. Both long-pulsed Nd:YAG laser and IPL are effective modes for hair removal. Although statistically insignificant, more side effects were noted with IPL than with long-pulsed Nd:YAG. However, in experienced hands this therapy is cheaper and more cost effective. It was seen that for Indian skin, diode laser was the ideal laser affecting coarse thick hairs, whereas IPL laser was not suitable for dark-skinned Indians as it targeted only fine hairs.

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**How to cite this article:** Puri N. Comparative study of diode laser versus neodymium-yttrium aluminum: garnet laser versus intense pulsed light for the treatment of hirsutism. *J Cutan Aesthet Surg* 2015;8:97-101.

**Source of Support:** Nil. **Conflict of Interest:** None declared.