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ORIGINAL CONTRIBUTION

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Comparison of hair removal efficacy and side effect of neodymium:Yttrium-aluminum-garnet laser and intense pulsed light systems (18-month follow-up)

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Summary

Background: Photothermal destruction of hair shaft melanin with intense pulsed light (IPL) and neodymium:yttrium-aluminum-garnet (Nd:YAG) laser has become an effective treatment of hair removal.

Aims: Our aim was to compare efficacy, satisfactory levels, safety, and side effects of Nd:YAG and IPL in hair reduction.

Methods: This was a prospective randomized intrapatient, right-left, assessor-blinded comparison of Nd:YAG vs IPL. There were 38 volunteers recruited. Seven sessions were performed. Hair count, efficacy, and side effects were compared before and after each treatment and 6 months after the last treatment. In respect of 12 volunteers, we have examined the reduction in hair after 18 months.

Results: Initially, there was no significant difference between the numbers of hair follicles. There was significant hair reduction after each treatment on the Nd:YAG-treated side. The hair reduction became significant after the third treatment with IPL. Comparison of the efficacy of the two devices on each visits showed no significant difference. There was statistically lower pain score on the IPL-treated side and statistically higher erythema, burning sensation, and edema on the Nd:YAG-treated side. Statistically lower side effect score was observed on the IPL-treated side. Eight months after the last treatment, there was significant hair reduction both on the Nd:YAG and on the IPL-treated side, and there was no difference between the efficacy. The patient satisfaction scores were higher with the IPL.

Conclusion: Unwanted hair can be reduced by both systems safely and effectively; however, IPL has less side effects and higher satisfaction scores.

KEYWORDS
hair removal, IPL, Nd:YAG

1 | INTRODUCTION

Laser hair removal is a fast-growing area in cosmetic dermatology. Photoepilator technologies have proved their efficacy, safety, and ease of use in the past 15 years. The use of lasers for hair removal is a safe and effective alternative to traditional epilation and depilation methods including shaving, waxing, tweezing, depilation, and electrolysis. The result of the traditional methods is temporary and irritating, in contrast to lasers which produce longer-term benefits with lower risk of complications.[1]

With the correct wavelength, pulse duration, and fluence, light can cause thermal injury to the absorbing chromophore, the melanin. In hair removal, the melanin-rich targets are the hair bulb and the hair shaft. [2,3]

After absorbing the light energy, photothermolysis is induced in hair follicle. To avoid the epidermal damage due to the absorption of the light by epidermal melanocytes, the interfollicular epidermis needs to be cooled down. The ideal candidate for the laser hair removal should have fair skin and dark terminal hair. The ideal wavelength to be absorbed selectively by the melanin and reach deep enough to the follicles is in the red and infrared spectrum. There are several light sources for hair reduction including ruby, alexandrite, long-pulsed neodymium:yttrium-aluminum-garnet (Nd:YAG), diode lasers, and intense pulsed light (IPL). [4-8]

There are differences among their indications, safety, and also economic considerations. The long-pulsed 1064 nm Nd:YAG laser can be used safely on dark skinned individuals.[9]

There are many different IPL systems with a broadband light source (400-1200 nm) from which the desired spectrum is filtered out using the appropriate cutoff filter. The epilation with these filters are reported to be as successful as laser systems, but the risk of burn and pigmentary changes are higher especially in darker skin types.[3]

Lasers usually apply scanner method, while IPL systems can use in motion technique to treat larger areas thus the overlapping or leaving out of areas can be avoided.

Hair removal with light using devices has become the most commonly used cosmetic procedure worldwide. Multiple choices are available to find the best treatment option for the patient depending on the skin type and treated areas.

There are many studies that compare the efficacy and safety of different light sources used in hair removal, but could we not find any study comparing Nd:YAG and IPL systems with a 18-month follow-up.

We aimed to compare the efficacy, satisfactory levels, safety, and side effects of Nd:YAG and (low energy) IPL in hair reduction with a 18-month follow-up period.

2 | MATERIALS AND METHODS

2.1 | Participants

It was a prospective, single-centered study approved by the University of Debrecen Medical Ethics committee (21019-1/2012/EKU (376/pi/12.). There were 38 untanned volunteers (skin phototype II-III). Inclusion criteria included skin phototype I-III, older than 18 years old with brown or black terminal hair. Exclusion criteria included active cutaneous inflammation or infection, active sunburn or intense tan, history of keloids and hypertrophic scarring, history of recurrent infections (herpes simplex), active vitiligo, and psoriasis at the targeted areas, patients who are on hormonal therapy, drugs with photosensitizing effects, any previous laser or electrolysis treatment and epilation or waxing within the period of 6 weeks, pregnancy, breastfeeding, and epilepsy.

2.2 | Devices

Nd:YAG laser (Quanta system light C) system on 1064 nm with a round spot size of 12 mm, adjustable fluences of 25-55 J/cm^2, pulse width 20-30 ms, and a contact cooling system.

IPL Alma laser (SHR) on 650-950 nm with a rectangular spot size of 5 cm^2, fluence 7 J/cm^2, (total energy/150 cm^2—10.0-13.0 kJ, total energy) pulse frequency of 3 -s and a contact cooling mechanism with in motion technique.

2.3 | Procedure

This was a prospective randomized intrapatient, right-left, assessor-blinded comparison of Nd:YAG laser vs IPL system. Each participant underwent a series of seven treatment sessions on the leg randomly selected the site and device at 4- to 6-week intervals. The whole leg was treated. A thin layer of ultrasound gel was applied to the treatment area as recommended by the manufacturer.

The setup and fluences used in both systems were within the recommended range based on skin type by the manufacturer (Table 1).

Hair count, efficacy, and side effects on both treated sides were compared before and after each treatment and 6 months after the last treatment. Furthermore, in respect of 12 volunteers, we examined the reduction in hair after 18-month follow-up period.

The same operator performed all treatments and was not involved in the assessment. For the accurate assessment, participants were instructed not to shave the hair on the treated areas 2 days prior each visit. Participants were instructed not to use any type of hair removal methods other than shaving, between the sessions and up to the last follow-up visit. Before the treatment and after the hair assessment, the would-be-treated area was shaved. After the treatment, cooling ice packs were used if it was required to reduce the pain. Local anesthesia was not applied. All of the standard safety measures were taken during the laser procedure.

Before the treatments and on the follow-up visits, digital photographs were taken by the same photographer using a digital camera (Canon Power Shot SX220 HS Digital Camera, Canon Inc., Tokyo, Japan) with equal lighting, position, and settings on a well-defined target 25-cm^2 area. In this area, the amount of hair was counted from the digital photographs in both sides. After every treatment, the participants scored the erythema, edema, burning sensation, and pain between 0 and 5. Participants scored the satisfaction based on a scale ranging from 0 (no improvement) to 100 (total disappearance of the hair) at 1, 3, 6, 18 months after the last

TABLE 1 The setup and fluence of Nd:YAG laser and IPL system

	Nd:YAG	IPL
Energy (pulse width)	25-55 J/cm^2 (20-30 ms)	7 J/cm^2
Spot size	12 mm (diameter)	5 cm^2
Frequency	1-1.5-2 Hz	3 Hz
Cooling	Contact	Contact

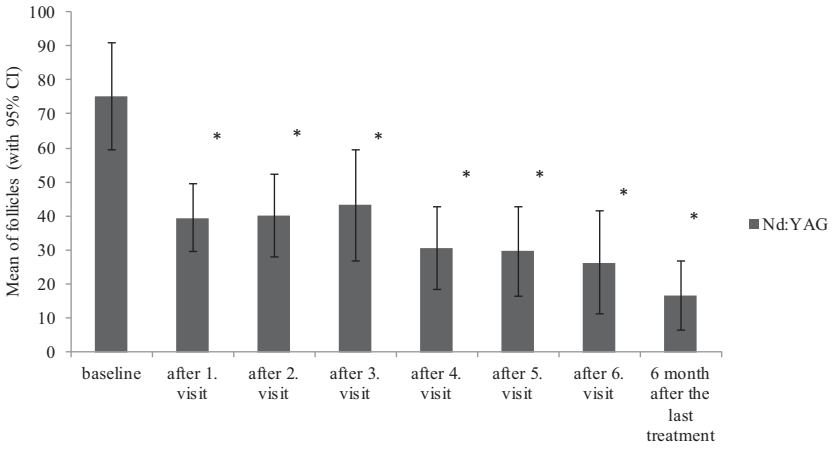

FIGURE 1 Compared to the baseline hair reduction after each treatment on the Nd:YAG-treated side (N=38). Analyzed with repeated-measures ANOVA test supplemented with Newman-Keuls post hoc test. *Significant compared to the baseline

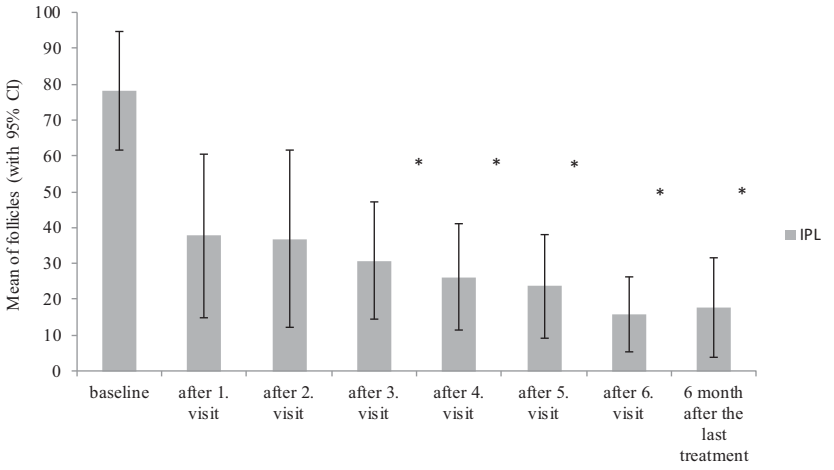

FIGURE 2 Compared to the baseline hair reduction after each treatment on the IPL-treated side (N=38). Analyzed with repeated-measures ANOVA test supplemented with Newman-Keuls post hoc test. *Significant compared to the baseline

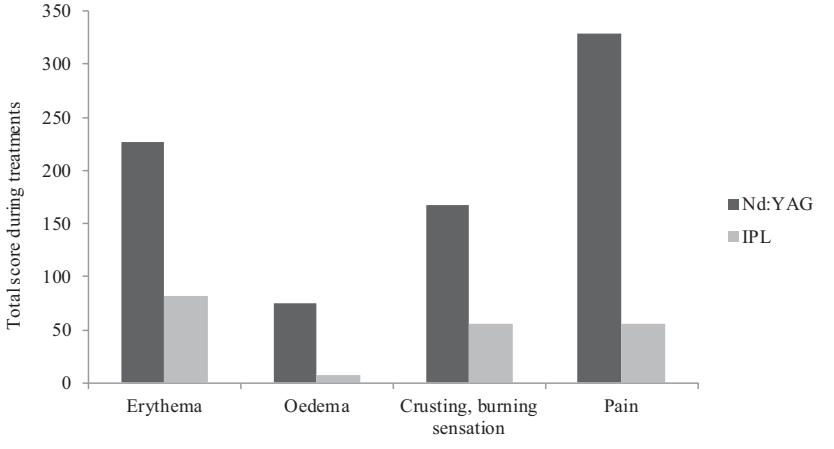

FIGURE 3 Comparison of Nd:YAG laser and IPL device, total score of side effects during treatments

treatment session. We also asked the patients whether they would use the applied treatment methods again or which one would they recommend to their friends.

Quantitative variables were described as means and standard deviations (SD). The data did not show normal distribution that is why it was normalized by logarithmic transformation. Comparing the two baseline characteristics and the effectiveness of the two treatments at each treatment time, we used dependent *t*-test. During the treatments, the change of the number of hairs was analyzed by repeated-measures ANOVA test supplemented with Newman-Keuls post hoc test. The side effects of compared two treatments were counted by sign test.

The significance level was .05.

Statistical analysis was performed by STATISTICA 13.1. (STATISTICA package for Windows, Release 13.1, StatSoft, Inc., Tulsa, OK, USA).

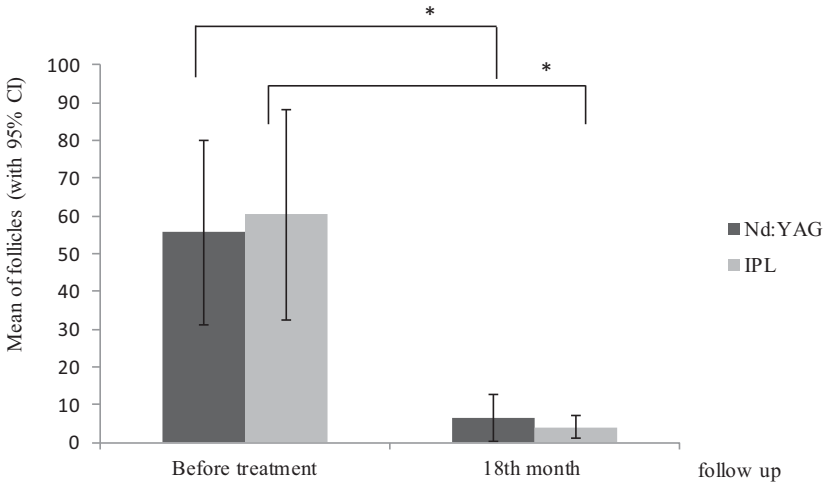

FIGURE 4 Eighteen months after the last treatment hair reduction both on the Nd:YAG-treated and on IPL-treated side (N=12). Analyzed with repeated-measures ANOVA test supplemented with Newman-Keuls post hoc test. *Significant compared to the baseline

3 | RESULTS

Among the 38 volunteers, 12 volunteers completed the 18-month study. Twelve participants were withdrawn from the study due to nonattendance at the long-term follow-up visits. The participants have skin phototype II and III.

Initially, there was no significant difference between the number of hair follicles (Nd:YAG: 75.16±49.52; IPL: 78.11±52.26 P=.510).

Thirty-eight volunteers had significant hair reduction after each treatment on the Nd:YAG-treated side compared to the baseline (P=.001; P=.003; P=.001; P<.001; P<.001; P<.001). Meanwhile, the hair reduction was not significant after the first and second treatment on the IPL-treated side (P=.079; P=.077), but became significant after the third treatment (P=.006; P=.004; P=.001; P<.001; Figure 1). Comparison of the efficacy of the two devices on each visits showed no significant difference (P=.738; P=.573; P=.093; P=.407; P=.180; P=.115). Six months after the last treatment on the Nd:YAG-treated side (P<.001) and also on the IPL-treated side (P<.001), we observed significant hair reduction compared to the baseline (Figure 2). There was no significant difference between the efficacy of the two treatments (P=.784).

There was statistically lower pain score (P<.001) on the IPL-treated side compared to Nd:YAG and statistically higher erythema (P<.001), burning sensation (P<.001), and edema (P<.001) on Nd:YAG-treated side compared to IPL (Figure 3).

Statistically lower side effect (P<.001) score was observed on IPL-treated side compared to Nd:YAG.

Analyzing the results of 12 volunteers 18 months after the last treatment, we observed significant hair reduction in both Nd:YAG- and IPL-treated side (P<.001, P<.001; Figure 4).

The patient satisfaction scores were higher with IPL system (86%) compared to Nd:YAG laser (62.5%). About 67% of the participants would apply again Nd:YAG laser, and 100% would apply IPL again. About 58% of the participants would recommend Nd:YAG treatment, and 100% of the participants would recommend IPL treatment.

4 | DISCUSSION

Hair removal with light-based devices has become one of the most commonly used cosmetic procedures worldwide. Several laser and light-based devices are in use for laser hair removal. There are many comparative studies on the efficacy, treatment outcome, and side effects between Nd:YAG and IPL systems in the management of hair removal, but this is the first study comparing Nd:YAG and IPL systems with 18-month follow-up period. The effectiveness of different light-based depilation devices varies significantly due to subjects biological variables such as anatomical location, epidermal pigmentation, duration of the hair follicle cycle, and androgen status.[10]

In this study, two devices were compared in the same subject, at the same anatomical location, at the same time. In our trial, we chose the lower limb as the anatomical site of study treatment because this area is suitable for a site-to-site comparison. In addition, only study participants of the skin phototype II and III were included, so differences in efficacy could be attached to the variables of the different light sources and not to the subject. In our trial, laser parameters were adapted only slightly during the treatments, and because of the affined skin phototypes, the setting parameters were almost the same. Finally, we made a decision on a 18-month follow-up period because of the lack of studies evaluating long-term effects of Nd:YAG- or IPL-based photo-epilation reviewing the literature.

In a number of studies, the long-pulsed Nd:YAG laser treatment has demonstrated to be a safe and effective method for hair removal.[9,11-14]

In a study by Goh, a single session, long-pulsed Nd:YAG laser treatment was found to be more effective than IPL therapy for hair removal in skin types IV-VI, with a preferable side effect profile. The author explained this with the long-pulsed Nd:YAG laser being able to penetrate 5-7 mm depth into the dermis in contrast to the short wavelength IPL system used in this study. In our study, we treated patients with II-III skin phototype seven times in a 4- to 6-week interval period, where we could use higher energy because the pigmentation side effects were low.[15]

Several studies have established the hair removal efficacy of IPL systems, and the clearance rate and satisfaction level vary greatly. In some studies, the satisfaction rate was as low as 33%, while other studies showed 90% clearance rate. [1,10,16-19]

Bjerring et al. compared the ruby laser and IPL and concluded that the IPL device was more effective for hair removal.[19]

Another study evaluated the efficacy and side effects of diode laser, alexandrite laser and IPL treatment for hair removal. They found no significant difference in efficacy between the groups.[20]

A retrospective review of long- and short-pulsed alexandrite lasers and IPL showed no difference in the efficacy between the treated sides; however, higher number of treatments was needed with IPL device to achieve the same benefit.[21]

In this study, Nd:YAG laser and IPL therapy reduced hair growth significantly. However, Nd:YAG treatment was also significantly painful, which may limit the use of this device especially on more sensitive skin areas.

In a study by Ismail, hair reduction 6 months after last treatment session was 54.4% on IPL and 79.4% on Nd:YAG-treated side; in our study, at 6 months the hair reduction was 68.1% and 64.4% on IPL- and Nd:YAG-treated sides, respectively.[11]

In a study comparing Alexandrite, diode and Nd:YAG lasers 2 months after three treatments, the reduction in hair was 70.3%, 59.7%, and 47.4%, respectively.[22]

In our study, 4-6 weeks after the third treatment, we found 26.6% reduction in Nd:YAG-treated side.

Subjective assessment of the outcome by the study participants suggested two therapies as equally effective, but IPL was preferred to Nd:YAG.

In other studies, treated subjects reported treatment discomfort, pain, and intense burning sensations after Nd:YAG treatment In our study, the patients reported pain, crusting, and burning sensation on Nd:YAG-treated side.[23-25]

Contact cooling was used in this study without any topical anesthesia, which helped in pain evaluation. The results were similar to literature findings, pointing that Nd:YAG laser-assisted hair removal can cause pain during the treatments.[26]

The advantages of IPL devices include lower cost and the ability to treat larger areas at the same time. Lasers are more expensive and time-consuming especially when large areas are being treated with a small tip.[27]

To reach our expected goal, we needed to set the optimal parameters after examination of the hair and skin color in the targeted area and we needed to inform our patients about the realistic expectations. With lower fluences, there is a higher possibility to achieve temporary and not permanent hair loss.

With the optimal parameters, each treatment session leads to 15%-30% hair loss.[3]

In conclusion, for hair removal in skin phototype II-III individuals, IPL (low energy in motion) system is a better choice than the long-pulsed 1064 nm Nd:YAG laser due to the higher levels of satisfaction.

This study is the first randomized controlled trial that compares the efficacy, safety, and side effect profile of Nd:YAG laser and IPL treatment for photo-epilation with a long-term follow-up of 18 months. We have shown that 18 months after the last treatment, there was a significant hair reduction in both Nd:YAG- and IPL-treated side.

The patient satisfaction scores were higher with IPL system compared to Nd:YAG laser.

Study participants rated Nd:YAG therapy as significantly painful and more often associated with a strong burning sensation compared to IPL treatment. About 100% of the participants would apply again and would recommend IPL treatment.

Both devices achieved long-term hair removal and induced only transient side effects. Our results refer to the settings used in this study for both devices and the skin sites treated. Results at other skin sites using different treatment parameters might differ from ours.

CONFLICT OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the manuscript.

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