The Effectiveness of 675 nm Wavelength Laser Therapy in the treatment Androgenetic alopecia among Indian patients.

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Abstract

Background: Androgenetic alopecia (AGA) is the most prevalent cause of male/female hair loss around the world.

Objective: the purpose of this study was to evaluate the efficacy of laser stimulation with 675 nm wavelength for the treatment of AGA in male and female Indian patients.

Methods: a total of 20 Indian healthy patients aged from 23 to 57 years and who presented a grade of Alopecia stage I to stage V, underwent one single pass of 675 nm laser in scalp area twice a week for a total of 8 sessions, followed by once a week for 4 sessions and once in 2 weeks for 2 sessions. At the end of treatment protocol patients have completed 14 laser sessions. Macro and Dermatoscopical images have been acquired at T0 (baseline) and T1 (4 months). The areas of scalp including vertex, frontal and parietal were evaluated. Many parameters were analysed including hair count and hair density of terminal, mean thickness, vellus follicules, total follicular units, units with 1 hair or 2,3,4 or more than 4 hairs, units density and average hair/unit.

Results: Macro images and dermatoscopic evaluation show good improvement over the entire treated area, with a clear increase in number of hairs and thickened hair. General parameters such as hair count and hair density show a percentage increase of around 17%. The hair mean thickness parameters shows a significant ($p<0.05$) percentage increase of 13.91%. Similar results were obtained for terminal hair and vellus: hair count and hair density terminal significantly ($p<0.05$) increased of 17.45%, hair count vellus significantly ($p<0.05$) increased of 16.67% and hair density vellus significantly ($p<0.05$) increased of 16.61%.

Conclusions: The study findings demonstrate that the 675 nm laser system improves AGA in Indian subjects, facilitating the anagen phase and improving the hair density and other positive hair parameters.

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OCL, TZ.; resources, B.SC, OCL; data curation, B.SC, OCL, FM, TZ; writing—original draft preparation, I.F, FM; writing—review and editing, B.SC, OCL, IF, FM, TZ; visualization, B.SC, OCL, IF, FM, TZ; supervision, B.SC, OCL, IF, FM, TZ; project administration, B.SC, OCL, TZ; funding acquisition, B.SC, OCL, TZ. All authors have read and agreed to the published version of the manuscript.

Abstract

Background: Androgenetic alopecia (AGA) is the most prevalent cause of male/female hair loss around the world. **Objective:** the purpose of this study was to evaluate the efficacy of laser stimulation with 675 nm wavelength for the treatment of AGA in male and female Indian patients. **Methods:** a total of 20 Indian healthy patients aged from 23 to 57 years and who presented a grade of Alopecia stage I to stage V, underwent one single pass of 675 nm laser in scalp area twice a week for a total of 8 sessions, followed by once a week for 4 sessions and once in 2 weeks for 2 sessions. At the end of treatment protocol patients have completed 14 laser sessions. Macro and Dermatoscopical images have been acquired at T0 (baseline) and T1 (4 months). The areas of scalp including vertex, frontal and parietal were evaluated. Many parameters were analysed including hair count and hair density of terminal, mean thickness, vellus follicules, total follicular units, units with 1 hair or 2,3,4 or more than 4 hairs, units density and average hair/unit. **Results:** Macro images and dermatoscopic evaluation show good improvement over the entire treated area, with a clear increase in number of hairs and thickened hair. General parameters such as hair count and hair density show a percentage increase of around 17%. The hair mean thickness parameters shows a significant ($p<0.05$) percentage increase of 13.91%. Similar results were obtained for terminal hair and vellus: hair count and hair density terminal significantly ($p<0.05$) increased of 17.45%, hair count vellus significantly ($p<0.05$) increased of 16.67% and hair density vellus significantly ($p<0.05$) increased of 16.61%. **Conclusion:** The study findings demonstrate that the 675 nm laser system improves AGA in Indian

subjects, facilitating the anagen phase and improving the hair density and other positive hair parameters.

Keywords: Androgenetic alopecia (AGA); 675 nm laser; Indian patients; hair restoration.

1. INTRODUCTION

On a worldwide scale, Androgenetic alopecia (AGA) represents the most common cause of male/female hair loss. Up to 70% of men and 40% of women are affected, primarily affecting the frontal and parietal regions of the scalp.

AGA can affect all races, but the prevalence rates vary. For men prevalence is considered to be highest in Caucasians [1,2].

] was the first to rate AGA severity from I to VII, which was then extended by Norwood [3] to include classes IIIa, IIIvertex, IVa, and Va. Male AGA phenotypic variants are graded using the universally accepted modified Norwood-Hamilton classification.

Indeed, AGA grade scores range from I to III for men according to the Norwood– Hamilton scale [4] and from I to II for women according to the Ludwig scale [5].

According to statistics, at least 50% of males by the age of 50 and a similar proportion of women by the age of 60 suffer from this medical disorder [6]. In a newest community-based study in Singapore, the 87% of Indians are affected, compared to over 61% of Chinese [7].

In the Indian context, a population-based study of 1005 subjects showed a 58% prevalence of AGA in males aged 30-50 years [8] and in a large study is reported that Indian population had type II as the commonest presentation of AGA [9] Another study conducted on Indian population found type II and III as the most common expression [10].

Affected individuals suffer grave psychological and emotional consequences [11]. Androgens, including testosterone and its derivatives, frequently cause androgenetic alopecia in genetically predisposed individuals [12]. It manifests as a gradually shorter anagen phase in terminal hair follicles and a final hair cycle transition from terminal to intermediate to vellus hair on the scalp in a characteristic pattern [13].

Receptor activation pathways play a role in the development of AGA in minicomplex organs. In this setting, the increased sensitivity to androgenic hormones in individuals with AGA negatively impacts the WNT/b-catenin signaling pathway, which is crucial for stimulating the anagen phase [14]. The hair follicles (HFs) in areas affected by AGA have an oval dermal papilla, a very thin matrix, low levels of melanin in the catagen phase, and often exhibit recurring non-destructive perifollicular microinflammation along with the deposition of mastocytes, macrophages, and lymphocytes. This condition leads to progressive follicular fibrosis and thickening of the fibrocollagenous sheath [15].

Currently, the US Food and Drug Administration (USFDA) has approved just three therapies for androgenetic alopecia: topical minoxidil, topical finasteride, and lower-level laser therapy.

However, some of these treatments can be associated with several side effects and unsatisfactory outcome.

Minoxidil is associated with a number of adverse reactions, including pruritus, scalp irritation, irritant and allergic contact dermatitis, cardiovascular system symptoms/signs in a dose dependent manner and facial hypertrichosis [16-18]. Although primarily utilized in dermatological application, Finasteride has been associated with hepatic dysfunction, unilateral breast enlargement and palpitations, libido reduction, head pain, fever, sexual dysfunction and neuropsychiatric side effects [19-21]. In clinical practice, various medication treatments like Progesterone, Azelaic acid, Zinc salts, Flutamide, Dutasteride and Spironolactone, as well as invasive techniques like platelet-rich plasma, scalp microneedling and hair transplantation, are commonly employed, but they have not demonstrated conclusive outcomes or promising prospects [17]. For this reason, research into specific treatments for androgenetic alopecia is needed.

Devices based on light-emitting diodes (LEDs) represent the most innovative and secure therapy solution for a range of diseases, such as aging, dysfunctional hair development, and skin inflammatory illnesses [22]. Numerous research studies have documented the efficaciousness of photodynamic treatment (PDT) in the management of hair loss [23]. When compared to alternative treatments, PDT provides patients with numerous advantages. It has a good safety profile, is non-invasive, affordable, and convenient for patients. Pharmacotherapy and other treatment methods can be combined or substituted with PDT [24].

The most common light source mentioned in the main reported evidence is represented by low-level laser therapy (LLLT) [25-28].

A recent published study [29] conducted on Indian patients, demonstrated that the application of LLLT in combination with minoxidil topical solution, can successfully raise the percentage of patients who recover from androgenetic alopecia as well as enhance patients' satisfaction with the treatments received for hair regrowth.

The efficacy of LED therapy with visible light has additionally been accepted as a valid adjuvant treatment in the recalcitrant form of alopecia areata [30].

Furthermore, real effectiveness in treating hair loss has recently been shown with LED therapy, especially with treatments that use red and infrared wavelengths.

The paper of Palma et colleagues reported the first case in which photobiomodulation therapy with a continuous wavered laser (660 nm) was successfully used as monotherapy for AA [31].

Particularly it has been demonstrated that the anagen phase, which is the active growth phase of HFs, can be stimulated with great success at a wavelength of 660 nm. Studies conducted in vitro demonstrate how red light can prolong the anagen phase and postpone the catagen transition [32]. Specifically, near-infrared light has been used to stimulate cell proliferation and differentiation of stem cells [33]. The resulting effect was established in vitro by the degree of expression of KI67, an indicative biomarker of cell proliferation in the hair matrix [34].

The recent published investigation of Sorbellini et al. [35] assessed the efficacy of 675 nm laser emission for the management of alopecia androgenetica in female and male subjects. The results showed a significant increase in the density of the hair shafts, resulting in a 60% reduction of the miniaturization process in the treated areas without side effect.

Based on these scientific findings, the purpose of this study was to evaluate the efficacy of laser stimulation with 675 nm wavelength for the treatment of AGA in male and female Indian patients for which currently only few studies are available.

2. MATERIAL AND METHODS

2.1 Recruitment

From August 2023 to March 2024, a total of 20 Indian healthy patients (7 females and 13 males) aged from 23 to 57 years and who presented a grade of Alopecia stage I to stage V, were enrolled. AGA severity ranges from I to V for men according to Norwood-Hamilton scale, and from I to III for women according to the Ludwig scale.

All subjects provided informed consent. AGA was diagnosed based on dermatological and clinical examinations. Exclusion criteria are the following: topical or systemic treatments for AGA in the 3 months preceding the study, systemic or cutaneous comorbidities on autoimmune basis or involving connective tissue, and pregnancy.

2.2 Device description

The RedTouch laser (Deka M.E.L.A, Calenzano, Italy) device was used in this research. The study device emits a wavelength of 675 nm and it is equipped with a 13x13 mm scanning system able to generate fractional microzones of 0.7 mm width (DOT area) of subablative and selective thermal damage on the skin. The presence of an integrated skin cooling system and the possibility to add a contact sensor minimizes downtime, possible adverse effects and protects the epidermal layer. This laser can have different effects on the skin. At low energies, it creates a reversible thermal area that biostimulates down to a depth of 3-6 mm, while increasing the energy results in the formation of a coagulation column down to a depth of 0.5-1 mm and also deeper reversible heating.

2.3 Study protocol and clinical photographic assessment

All patients underwent one single pass of 675 nm laser in scalp area twice a week for a total of 8 sessions, followed by once a week for 4 sessions and once in 2 weeks for 2 sessions. The duration time of each session was 20 minutes, and the following parameters were selected: Power 1 W, dwell time 100 ms, Stack 1, spacing of 1000 µm and a cooling temperature set at 15 ^{o} C. At the end of treatment protocol patients have completed 14 laser sessions.

Macro and Dermatoscopical images have been acquired at T0 (baseline) and T1 (4 months).

For Dermoscopy analysis Fotofinder device was used (FotoFinder Trichoscale System, GmbH 1000, Bad Birnbach, Germany) at T0 (baseline) and T1 (4 months). The comparison of the dermatoscopic analysis of each patient at baseline and at 4th months was carried out for quantitative assessment of the hair. The areas of scalp including vertex, frontal and parietal were evaluated.

Many parameters were analysed including hair count and hair density of terminal, mean thickness, vellus follicules, total follicular units, units with 1 hair or 2,3,4 or more than 4 hairs, units density and average hair/unit.

Hair count and hair density indicate the number of hairs in the analysed area without distinguishing between terminal hairs and vellus (which is analysed with the next two parameters). Finally, there are the total number of follicular units, the density of the units, the number of hairs per follicular unit and the average number of hairs per unit. An increase in the number of follicular units, mean thickness and a higher number of hairs per follicular unit is taken as positive outcome at the end of 4th month (T1).

2.4 Side effects

Possible side effects such as hair burn, blistering, scarring, burns, hypopigmentation or hyperpigmentation that may result from the use of given energy levels are monitored for the entire treatment period.

2.5 Pre-treatment procedure

In order to prevent light reflections and to keep the handpiece's cooling temperature uniformly, the patient's skin and hair were soaked with water prior to the treatment. Hair gel was not used in an effort to increase the patient's comfort and to ease the patient's exit from the treatment.

2.6 Statistical analysis

All clinical data were reported as means ± standard deviations. The statistical analysis was carried out using a Student t-test. A p-value of 0.05 was selected as cut-off for significance.

3. RESULTS

Macro and Dermoscopy images of patient's scalp area taken at T0 and T1, were subjected to quantitative evaluation (Table 1).

Macro and dermoscopy images show good improvement over the entire treated area, with a clear increase in number of hairs and thickened hair (Figures 1-7).

These data were confirmed by the quantitative dermatoscopic evaluation. General parameters such as hair count and hair density show a percentage increase of around 17%.

The hair mean thickness parameters shows a significant ($p<0.05$) percentage increase of 13.91%. Similar results were obtained for terminal hair and vellus: hair count and hair density terminal significantly ($p<0.05$) increased of 17.45%, hair count vellus significantly ($p<0.05$) increased of 16.67% and hair density vellus significantly ($p<0.05$) increased of 16.61%. This increase is even more evident in the histogram (Figure 8).

Confirming the improvements obtained, a significantly ($p<0.05$) increase in follicular units with 4 or more hairs was observed (Figure 9). This is a crucial aspect, since having more hair per follicular unit correspond to a greater hair density, giving the appearance of a thicker scalp, a sign of young and healthy hair.

Table 1. Mean of clinical parameters of 20 patients at baseline (T0) and follow-up (T1) and its percentage difference

	T0	T1	Percentage difference%
Hair Count *	104.62 ± 23.71	122.60 ± 30.19	+ 17.19 %
Hair density [/cm²]*	115.82 ± 26.24	135.72 ± 33.42	+ 17.18 %
Hair count Terminal *	69.58 ± 18.37	81.72 ± 19.00	+ 17.45 %
Hair Count Vellus	35.04 ± 19.83	40.88 ± 16.67	+ 16.67%
Hair density terminal* [/cm²]	77.03 ± 20.33	90.47 ± 21.03	+ 17.45 %
Hair density vellus [/cm²]	38.81 ± 21.93	45.26 ± 23.58	+ 16.61 %
Mean Thickness [mm]*	0.05 ± 0.01	0.06 ± 0.01	+13.91%
Total Follicular Units*	91.36 ± 11.69	100.85 ± 12.45	+10.39 %
Units (1 hair)	50.71 ± 3.44	51.90 ± 4.34	+ 2.35 %
Units (2 hairs)*	27.62 ± 5.37	32.01 ± 5.29	+ 15.89 %
Units (3 hairs)*	9.89 ± 3.33	11.71 ± 3.60	+ 18.40 %
Units (4 + >4 hairs)*	3.14 ± 2.21	5.21 ± 2.09	+ 69.92%
Units density* [/cm²]	101.24 ± 13.10	109.64 ± 16.03	+ 8.30 %
Average hair/unit*	1.61 ± 0.12	1.71 ± 0.10	+ 5.97 %

*Statistically significant clinical data (p<0.05)

Figure 1. Scalp area of Indian male patient before (A) and after 14 sessions with 675 nm laser (B). A clinical improvement and restoration of scalp's central hairline hairs from baseline (T0) to 4 months follow-up (T1) were observed.

Figure 2. Scalp area of Indian male patient before (A) and after 14 sessions with 675 nm laser (B). A clinical improvement and restoration of scalp's central hairline hairs from baseline (T0) to 4 months follow-up (T1) were observed.

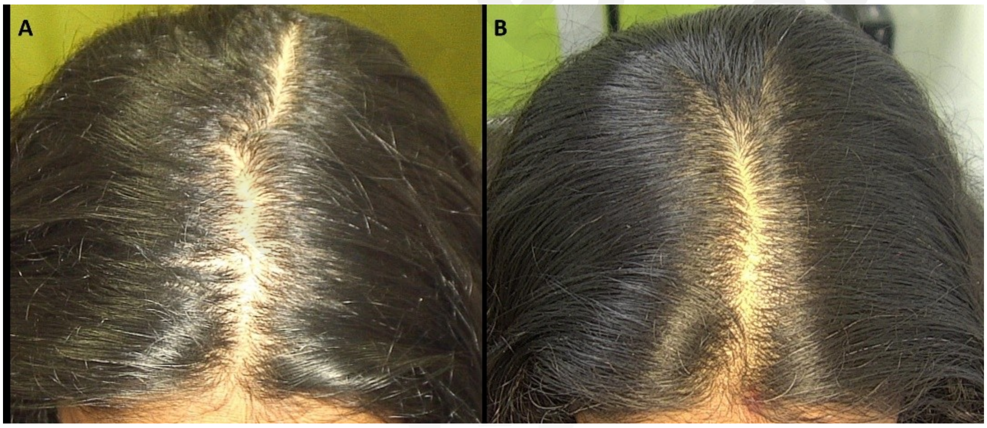

Figure 3. Scalp area of Indian female patient before (A) and after 14 sessions with 675 nm laser (B). A clinical improvement and restoration of scalp's central hairline hairs from baseline (T0) to 4 months follow-up (T1) were observed.

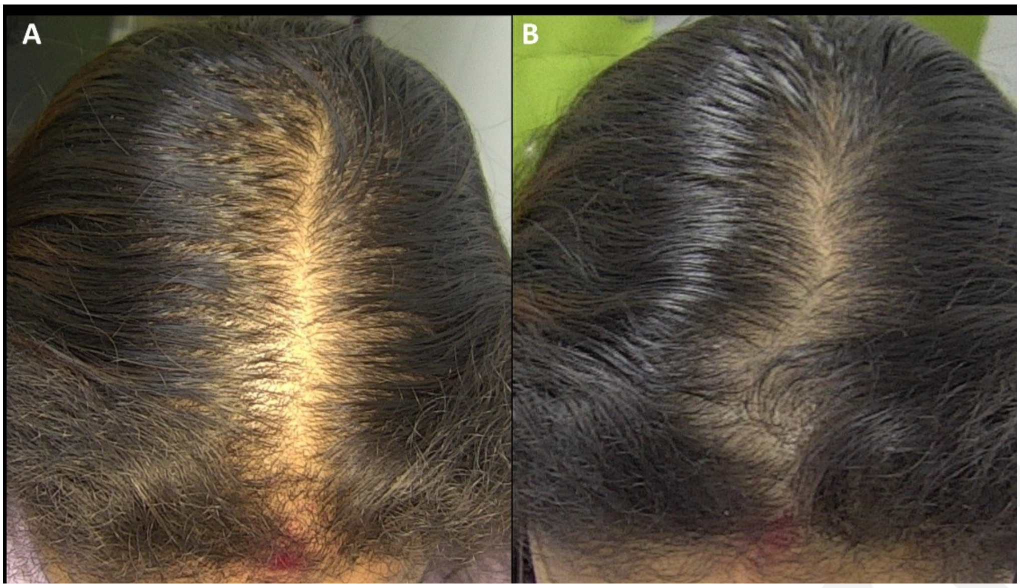

Figure 4. Scalp area of Indian female patient before (A) and after 14 sessions with 675 nm laser (B). A clinical improvement and restoration of scalp's central hairline hairs from baseline (T0) to 4 months follow-up (T1) were observed.

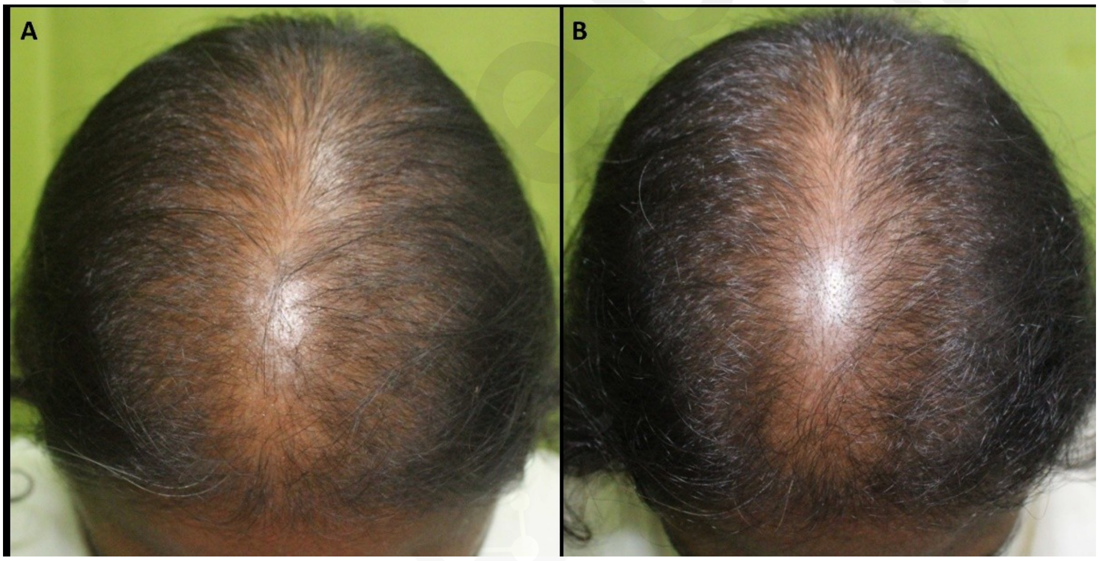

Figure 5. Scalp area of Indian female patient before (A) and after 14 sessions with 675 nm laser (B). A clinical improvement and restoration of scalp's central hairline hairs from baseline (T0) to 4 months follow-up (T1) were observed.

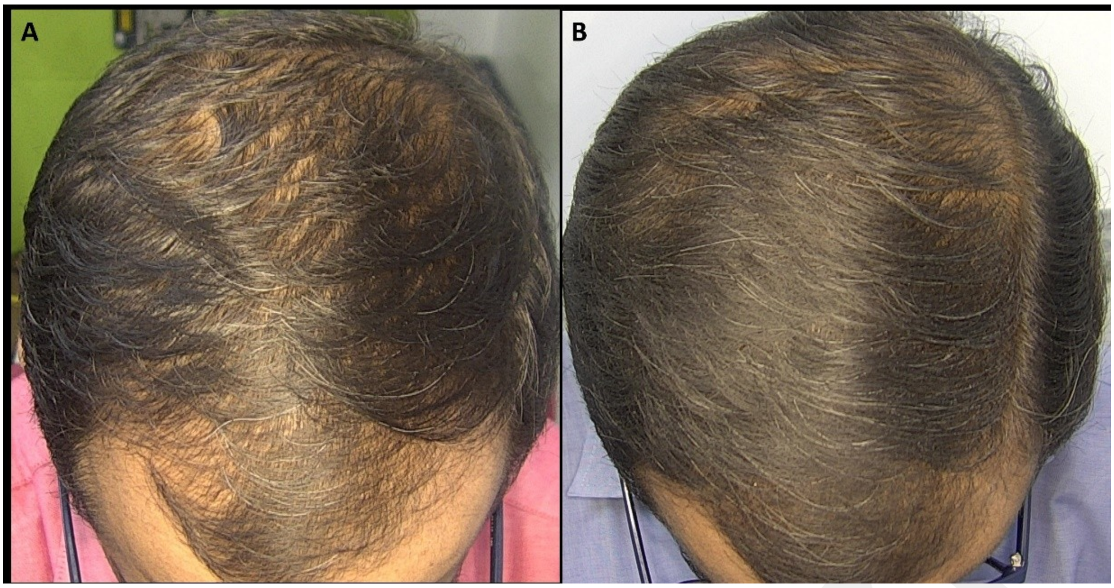

Figure 6. Scalp area of Indian male patient before (A) and after 14 sessions with 675 nm laser (B). A clinical improvement and restoration of scalp's central hairline hairs from baseline (T0) to 4 months follow-up (T1) were observed.

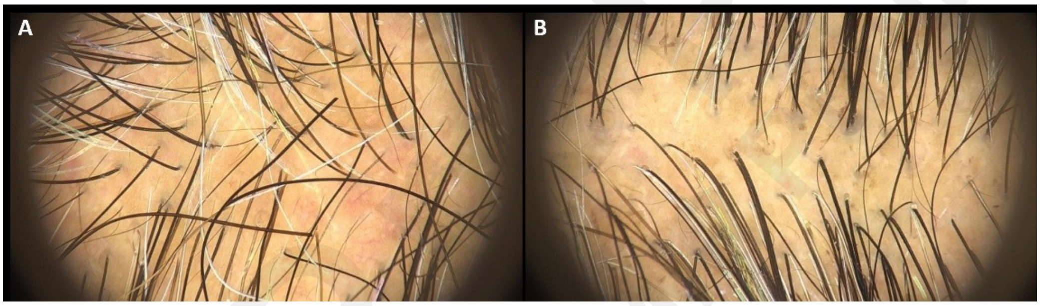

Figure 7. Dermatoscopy imaging of patient's scalp area before (A) and at 4 months follow up (B). A clinical improvement and restoration of scalp's central hairline hairs were observed.

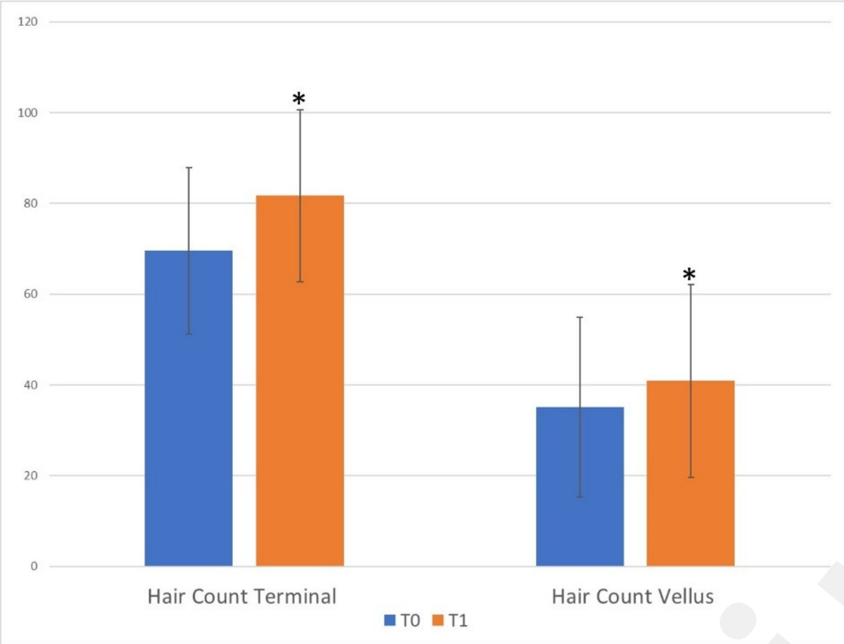

Figure 8: Histogram of hair count terminal and hair count vellus at baseline (T0) and at follow-up (T1).

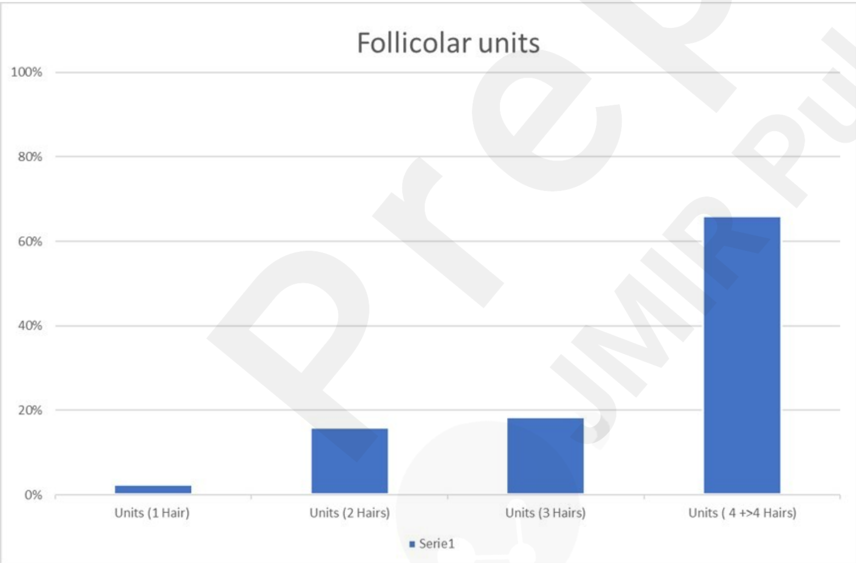

Figure 9: Percentage difference of follicular units with 1,2,3,4 or more hairs per unit.

4. DISCUSSION

When standard and established treatments are less effective or less productive, laser therapy offers an extra therapeutic option and is a useful adjunct to traditional therapies. For patients who are unable or unwilling to take drugs or inject platelet-rich plasma (PRP), it may be the ideal option for growing hair and preventing future progression. There are various medications available for the management of AGA, as was previously mentioned in the introduction section. Other minimally invasive methods, like the use of pulsed electromagnetic field therapy, also showed a positive biological effect on hair regrowth and were used in combination with laser therapy for the clinical treatment of AGA [36]. Among laser treatment modalities, red light, which has a skin penetration depth of 1–6 mm, improves blood circulation and promotes cell metabolism, nutrition supply to capillaries and strengthens hair strands, anchoring follicles and pain relief (seen as additional advantage in cases of trichodynia). The other techniques, unlike laser therapy, achieved good results but required a greater number of sessions at the same time, and the injected substances and needle pricks are not always tolerated by the patient. Red and near-infrared lasers can prolong the anagen growth phase of the HF, promoting an increase in hair count in patients without significant side effects [37]. Among the aforementioned laser treatment modalities, red light, with its 1-6 mm skin penetration depth, is the most effective in promoting cell metabolism, blood circulation, capillary nourishment delivery, cuticle anchorage, and pain relief.

The study device interacts with water and the vascular component minimally while having a strong affinity for collagen and melanin. In contrast to laser systems that use wavelengths <650 nm, which are highly absorbed by hemoglobin, and wavelengths >950 nm, which are primarily absorbed by water, this novel device, with a wavelength of 675 nm, operates directly on the collagen component based on its spectrum absorption coefficient. In this manner, the heat reaches the collagen fibers directly, bypassing other chromophores.

Within 3 months of the treatment sessions, the qualitative and quantitative results demonstrate a significant increase in the number of vellus hairs compared with terminal hairs, indicating the revival of dormant follicles resulting in hair restoration.

The study limitations is mainly represented by a small population sample and short follow up.

Additional investigations on bigger population sample will be required to standardize the criteria employed. A longer follow-up period will be expected to see whether the laser's effects on hair growth are lasting. As a future goal we plan to execute immunohistochemical or histological analyses.

Comparable to previous scientific research, this study looked at different parameters of more accuracy like, a better hair counts/density, length, thickness and follicular ratio, a photographic evaluation and dermatoscopy analysis. Additionally, dermatoscopy facilitated treating physicians to examine the skin post-therapy and to observe optimum end point.

The 675 nm wavelength treatment is easy to administer and produces a minimally invasive therapy for patients as it doesn't burn pre-existing hair, no recovery period for the patient, and keep them free from needle phobia and pain.

According to the research by Sorbellini et al. which was previously mentioned in the introduction section, 675 nm laser treatment has proven effective in improving AGA in young subjects, managing to preserve the intact epidermis and hair shaft. Indeed, the biostimulation parameters selected in this study did not damage the HF and to perform procedure with intact hair length.

The data reported in our study showed that there has been a 17% increase in hair length measurable parameters such as hair count, hair density and hair thickness. Similar results were obtained for terminal hair and vellus.

Additionally, follicular units containing four or more hairs increased, suggesting hair revival leading to improvement in hair density and the appearance of a fuller scalp.

As confirmed by the results of the current study and those previously published, the 675 nm laser device promises a uniform, rapid, safe, and effective method of treatment of AGA, with minimal discomfort to the patients, as well as, has the potential to be combined with other treatment options.

5. CONCLUSION

The results of the study demonstrate that the 675 nm laser system improves AGA in Indian subjects, facilitating the anagen phase and improving the hair density and other positive hair parameters, minimizing the risks of side effects when compared to other conventional interventions.

Conflicts of Interest: Authors TZ, FM and IF were employed by El.En. Group. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Abbreviations

AGA: Androgenetic alopecia
HFs: hair follicles
USFDA: US Food and Drug Administration
LEDs: light-emitting diodes
PDT: photodynamic treatment
LLLT: low-level laser therapy
PRP: platelet-rich plasma

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