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# INVESTIGATING THE IMPACT OF LOW-LEVEL LASER TREATMENT ON HAIR GROWTH AND SCALP HEALTH

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## ABSTRACT

**Background:** In terms of aesthetics, the look of the scalp and hair is critical, regardless of gender or age. However, a range of therapeutic procedures and medicines have been proposed for hair loss and scalp issues, but the results have been insufficient.

**Aim** The current study investigated the effects of low-level laser treatment on hair growth and scalp problems.

**Methods:** Sebum secretion on the scalp, erythema index, Global Aesthetic Improvement Scale score, and photrichogram for hair thickness and density were measured in all trial participants at baseline, 12 weeks, and 24 weeks.

**Methods**: After 24 weeks of therapy, there was a substantial increase in hair thickness and density ($p=0.01$, $<0.1$). Sebum secretion decreased significantly from the vertex region ($p < 0.1$). Of the 98 research participants, 73.47% (n=72) improved their overall scalp look.

**Conclusions**: Using a helmet-like low-level laser treatment equipment can assist improve the overall appearance of hair by increasing density and thickness. It can help enhance the condition of the scalp by reducing sebum production.

**Keywords:** Hair loss, low-level laser therapy, scalp, sebum, bronchogram

## INTRODUCTION

androgenetic alopecia is the most frequent kind of hair loss in both men and women. Androgenetic alopecia can occur at any age following puberty. The severity of androgenetic alopecia gradually increases as the afflicted patients mature. As a result, therapeutic treatment seeks to either entirely stop the process or prevent it from progressing rapidly. Hair loss is an important feature of the esthetic component, and it can have a negative impact on the quality of life in afflicted individuals regardless of severity, age, or gender. Many medications have been developed to treat hair loss, but they have been linked to systemic side effects that have raised concerns among many people. Additionally, many people struggle to take these drugs for long periods of time due to adverse effects or poor response. Off-label topical agents are also available for treating hair loss, but their efficacy remains uncertain.

The effectiveness of low-level laser treatment varies according on the wavelength of light used. Low-level laser treatment offers a variety of applications in dermatology, including skin renewal, pain relief, inflammation reduction, and wound healing

stimulation.3 The main biological mechanism underlying low-level laser treatment is the lengthening of the anagen phase through the stimulation of Wnt/b-catenin and extracellular signal-regulated kinase signaling pathways. According to available literature, low-level laser treatment helps to modulate cytokine levels and growth factors by changing gene expressions such as hypoxia-inducible factor, nuclear factor kappa-B, and activator protein 1. Low-level laser treatment also promotes cell proliferation and migration, as well as protein synthesis.4

Low-level laser treatment devices have been shown to promote hair growth, although the ideal wavelength for LLLT has not been properly established or documented in prior research.5 The current study examined infrared wavelengths of 820-880 nm and 910-970 nm, as well as red light of 630-690 nm. The study primarily sought to explore the effects of low-level laser treatment as a helmet-like device on hair growth and scalp conditions in people with androgenetic alopecia.

## MATERIALS AND METHODS

The current prospective clinical trial sought to investigate the effects of low-level laser treatment delivered via a helmet-like device on hair growth and scalp conditions in people with androgenetic alopecia. Secondary outcomes investigated in the study were the erythema index and sebum secretion. The research was conducted in the Department of Psychiatry at Madhubani Medical College in Bihar. The research subjects were from the Institute's Department of Dermatology. Prior to participation, all study subjects provided verbal and written informed consent.

The study's inclusion criteria were adult girls and males aged 18 to 65 who were healthy and motivated to improve the look of their hair and scalp. A diagnosis of androgenetic alopecia was established using the Ludwig classification for females and the Norwood-Hamilton classification for men. Throughout the trial, all volunteers were requested to avoid from using hair products that might harm hair development or the scalp, and to keep the same haircut and color.

Subjects with hair disorders other than androgenetic alopecia that could affect hair growth, subjects who had used products such as minoxidil, cyclosporin, finasteride, or steroids within the previous 6 months, and subjects taking any systemic or local medication known to affect hair growth were all excluded from the study.

The device utilized in the study was a helmet-shaped equipment that radiated 1.3 mW/cm2 at 630-690, 820-880, and 910-970 nm wavelengths. The diode numbers utilized for each listed wavelength were 240, resulting in a total of 720. All participants used the equipment in their own homes. After 20 minutes of therapy, the gadget automatically shut off.

The primary outcomes examined in the research were changes from baseline in hair thickness and density on the scalp's vertex at 12 and 24 weeks. The phototrichogram was used to draw a virtual circle with a 1cm2 area on the scalp vertex. The investigators and participants assessed the scalp and hair using the Global Aesthetic Improvement Scale. Data on participant subjective satisfaction was also collected, as shown in Table 1.

The Global Aesthetic Improvement Scale scores are as follows: -2 for severe deterioration, -1 for moderate degradation, 0 for no change, +1 for mild improvement, +2 for considerable improvement, and +3 for remarkable improvement.

* Points on the global aesthetic rating scale: 3 for severe deterioration, 2 for moderate deterioration, 1 for mild deterioration, 0 for no change, +1 for mild improvement, +2 for moderate improvement, +3 for noticeable improvement. Before starting therapy, biophysical measures were obtained at baseline, 12 weeks, and 24 weeks. The skin melanin indices, sebum production, and erythema index were measured using a combination of sebumeter, viscometer, hexameter, and chronometer equipment. All parameters were examined three times, and the mean value was used in the study. The examiners evaluated safety measures such as adverse effects and vital signs, which were reported by the participants at all assessment points, including baseline, 12 weeks, and 24 weeks.

The collected data were evaluated statistically using the SPSS software version. 21.0 (IBM Corp., Armonk, NY, USA) and unpaired t-test with the chi-square test. The data were expressed as mean and standard deviation and frequency and percentage. Statistical significance was kept at a p-value of $<0.05$.

## RESULTS

Over a 24-week period, the current study evaluated 100 participants. For 24 weeks, all 100 research participants were exposed to a helmet-shaped device that emitted light at wavelengths of 630-690, 820-880, and 910-970 nm for 20 minutes every day. The research first examined 100 participants. Two respondents were eliminated from the research due to non-compliance, resulting in a final sample size of 98 subjects, with 51.02% (n=50) men and 48.98% (n=48) females. The average age of

research participants was 44.3±11.7 years. Among 48 females, 95.83% (n=46) were from Ludwig Classification I, whereas 4.16% (n=2) were from Ludwig Classification III.

Among 50 guys, 20% (n=10) were classified as Norwood Hamilton I and II, whereas 40% (n=20), 4% (n=2), 8% (n=4), and 8% (n=4) were classified as Norwood Hamilton III, IV, V, and VI. Hair density and thickness averaged 117.65±28.19/cm2 and 48.94±9.54 µm. The average erythema index, melanin index, and sebum secretion were 164.71±73.48, 297.02±76.07, and 43.59±54.83 on the vertex, and 177.16±77.29, 281.02±76.98, and 46.49±55.27 on the frontal area, respectively (Table 1). All research individuals had their age at enrollment correlated with sebum secretion, erythema index, number of hair strands, and hair thickness.

Older participants had considerably fewer strands and thinner hair (p=0.001). Erythema indices were greater in older patients in both the vertex and the frontal regions (p=0.002). There was no association found between the amount of sebum secreted and the age of the participants, or between erythema and sebum production. At all evaluation occasions, participants completed a questionnaire that described their time using the equipment for 20 minutes. The formula for assessing compliance was:

Compliance (%) = [actual number of trials x 100] / Total number of trials required.

The total number of trials required was the number of days between the final visit date to return the machine and the first visit date to receive the machine.

Throughout the trial, no patients reported any major side effects such as hair loss, allergic reactions, or extreme discomfort. At 24 weeks, respondents were also asked to rate their overall happiness with the gadget using a pre-designed questionnaire. The questionnaire consisted of five items: hair growth rate, hair thickness, number of hair strand dropouts, change in hair richness, and overall look of scalp and hair, which were graded on a seven-point scale. Among 98 subjects, 73.47% (n=72) improved their overall scalp appearance, 61.22% (n=60) increased their hair richness, 65.31% (n=64) decreased their number of hair dropouts, 59.18% (n=58) increased their hair thickness, and 67.35% (n=66) increased their hair growth rates.

At the 12-week evaluation, 93.55% (n=92) participants had better hair conditions compared to the baseline, whereas at the 24-week examination, 91.84% (n=90) patients showed overall improvement compared to the previous assessment. No decline in the number of participants was observed at any visit. At 12 weeks, 6.12% (n=6) of the individuals had no alterations in their hair, whereas at 24 weeks, 8.16% (n=8) did.

There was a significant increase in vertex hair density between baseline and 12 weeks and baseline and 24 weeks, with p-values <0.01. Hair thickness in the vertex area increased significantly at 12 and 24 weeks (p<0.01 and 0.01, respectively). At 24 weeks, the vertex area of the scalp showed a substantial decrease in sebum index ($p < 0.1$). However, there was no significant difference between the erythema index and the melanin index at any evaluation period.

**DISCUSSION**

The average age of 98 research participants was 44.3 ± 11.7 years. Among 48 females, 95.83% (n=46) were in Ludwig Classification I, whereas 4.16% (n=2) were in Ludwig Classification III. Among 50 guys, 20% (n=10) were classified as Norwood Hamilton I and II, whereas 40% (n=20), 4% (n=2), 8% (n=4), and 8% (n=4) were classified as Norwood Hamilton III, IV, V, and VI. Hair density and thickness averaged 117.65±28.19/cm2 and 48.94±9.54 µm. The average erythema index, melanin index, and sebum secretion were 164.71±73.48, 297.02±76.07, and 43.59±54.83 on the vertex, and 177.16±77.29, 281.02±76.98, and 46.49±55.27 on the frontal area. These findings were similar to those of Pappas A et al6 and Kim H et al7 in 2013, who evaluated participants with hair loss using demographic data similar to the current investigation.

The study findings revealed that there was a link between the study subjects' ages at enrollment and sebum production, erythema index, number of hair strands, and hair thickness. There were substantially less strands in elderly patients (p=0.001), as well as much thinner hair.

Erythema indices were greater in older patients in both the vertex and the frontal regions (p=0.002). There was no correlation between the quantity of sebum production and the individuals' age, or between erythema and sebum secretion. These findings were consistent with the findings of Mai-Yai Fan S et al8 in 2018 and Chung H et al9 in 2012, who presented results similar to the current study regarding the correlation between the age of the study subjects at enrollment and sebum secretion, erythema index, number of hair strands, and hair thickness. Throughout the trial, no patients reported any major side effects such as hair loss, allergic reactions, or extreme discomfort.

Among 98 subjects, 73.47% (n=72) improved their overall scalp appearance, 61.22% (n=60) increased their hair richness, 65.31% (n=64) reduced their number of hair dropouts, 59.18% (n=58) increased their hair thickness, and 67.35% (n=66)

increased their hair growth rates. These findings were consistent with those of Kwon HH et al.10 (2013) and Gui Y et al.11 (2012).

At 12 weeks of evaluation, 93.55% (n=92) patients had improved hair conditions compared to the baseline, while at 24 weeks of assessment, 91.84% (n=90) subjects showed overall improvement compared to the previous assessment.

No decline in the number of participants was observed at any visit. At 12 weeks, 6.12% (n=6) of the individuals had no alterations in their hair, whereas at 24 weeks, 8.16% (n=8) did. These findings were consistent with Sommer AP12 in 2019 and Ferraresi C et al13 in 2015, who both reported significant improvements in hair loss and scalp appearance after LLLT. The study found a significant increase in vertex hair density between baseline and 12 weeks and baseline and 24 weeks (p-values <0.01). Hair thickness in the vertex area increased significantly at 12 and 24 weeks ($p<0.01$ and 0.01, respectively).

A substantial reduction in sebum index was seen in the vertex region of the scalp at 24 weeks ($p < 0.1$). However, there was no significant difference in the erythema and melanin indexes at any evaluation period. These findings were consistent with the findings of Kim JE et al14 and Moskvin SV15 in 2019, who found that LLLT improves hair density while decreasing melanin and sebum production and improving the erythema index.

## CONCLUSION

Using a helmet-like low-level laser treatment equipment can improve hair density and thickness, leading to a better overall look. It can also help to promote scalp health by reducing sebum production. However, more research with bigger sample numbers and longer monitoring periods are required.

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| S. No | Assessment | Global aesthetic improvement scale -3 to 3 |
|---|---|---|
| **1.** | **By examiner** | |
| **a)** | Global photographic assessment | |
| **2.** | **By subjects** | |
| **a)** | Hair growth change | |
| **b)** | Hair thickness change | |
| **c)** | Changes in hair strand dropouts | |
| **d)** | Hair richness changes | |
| **e)** | Overall scalp and hair appearance | |

**Table 1: Questionnaire on global assessment of scalp and hair**

| S. No | Characteristics | Number (n=98) | Percentage (%) |
|---|---|---|---|
| **1.** | **Mean age (years)** | 44.3±11.7 | |
| **2.** | **Gender** | | |
| **I.** | **Females** | 48 | 48.98 |
| **a)** | Ludwig classification -I | 46 | 95.83 |
| **b)** | Ludwig classification -II | 0 | 0 |
| **c)** | Ludwig classification -III | 2 | 4.16 |
| **II.** | **Males** | 50 | 51.02 |
| **a)** | Norwood Hamilton classification-I | 10 | 20 |
| **b)** | Norwood Hamilton classification-II | 10 | 20 |
| **c)** | Norwood Hamilton classification-III | 20 | 40 |
| **d)** | Norwood Hamilton classification-IV | 2 | 4 |
| **e)** | Norwood Hamilton classification-V | 4 | 8 |
| **f)** | Norwood Hamilton classification-VI | 4 | 8 |
| **3.** | **Mean hair density/cm2** | 117.65±28.19 | |
| **4.** | **Mean hair thickness (µm)** | 48.94±9.54 | |
| **5.** | **Vertex** | | |
| **a)** | Mean Erythema index | 164.71±73.48 | |
| **b)** | Mean melanin index | 297.02±76.07 | |
| **c)** | Mean sebum secretion | 43.59±54.83 | |
| **6.** | **Frontal** | | |
| **a)** | Mean Erythema index | 177.16±77.29 | |
| **b)** | Mean melanin index | 281.02±76.98 | |
| **c)** | Mean sebum secretion | 46.49±55.27 | |

**Table 2: Baseline data of the study participants**

| S. No | Compliance | Results |
|---|---|---|
| **1.** | **Total** | |
| **a)** | Number (n) | 98 |
| **b)** | Mean ± S. D | 94.50±3.19 |
| **c)** | Min-Max | 83.81±97.12 |

**Table 3: Treatment compliance in the study subjects**