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STUDYING THE EFFECTS OF LOW-LEVEL LASER THERAPY ON HAIR GROWTH AND SCALP CONDITIONS

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ABSTRACT

Background: Androgenetic alopecia is the most frequent kind of hair loss that affects both men and women. After puberty, androgenetic alopecia can appear at any age. As the age of the afflicted people increases, there is a progressive escalation in the severity of androgenetic alopecia.

Aim: the goal of therapeutic treatment is to either fully halt the process or stop it from progressing too quickly.

Methods: A verified diagnosis of androgenetic alopecia based on the Norwood-Hamilton classification for men and the Ludwig classification for women. All of the individuals were instructed to keep their hair colour and style the same and to abstain from using any hair products that may impact their scalps or hair development during the research period. Sebum secretion from the scalp, erythema index, Global Aesthetic Improvement Scale score, and photrichogram for thickness and density of hair were measured at baseline, 12 weeks, and 24 weeks in all research participants.

Results: The study's findings demonstrated that, 24 weeks after treatment, there was a statistically significant increase in hair density and thickness ($p=0.01$ and <0.1, respectively). Additionally, sebum excretion from the vertex region was significantly reduced ($p<0.1$). Improvement in the overall look of the scalp was seen in 73.47% ($n=72$) of the 98 research participants.

Conclusions: This study shows that using low-level laser treatment equipment that resembles a helmet can assist to improve the overall look of hair by increasing its density and thickness. Because it reduces sebum secretion, it can also help with scalp conditions.

Keywords: Bronchogram, scalp, sebum, hair loss, low-level laser treatment

INTRODUCTION

Hair loss is a significant part of the aesthetic component, and regardless of its severity, age, or gender, it can have a negative impact on an individual's quality of life. Numerous medications have been created to address hair loss.1. Most of the participants, however, are concerned about these medications since they have been linked to systemic adverse effects. Additionally, because of the negative effects or the inadequate response, most people find it difficult to continue taking these medications for an extended period of time. Furthermore, a plethora of pharmaceuticals and off-label topical treatments are available to treat hair loss; however, their effectiveness has not been empirically demonstrated.2

The area of dermatology has been using LLLT (low-level laser treatment) for a number of years to treat a variety of clinical symptoms and illnesses, such as hair loss, inflammation, pain, and wounds. There are differences in the effectiveness of low-level laser treatment depending on the wavelength of light used. In dermatology, low-level laser treatment has several other applications, such as skin renewal, pain management, inflammatory reduction, and promotion of wound healing.3. Low-level laser therapy's fundamental biological process involves extending the anagen phase by activating the signalling pathways for extracellular signal-regulated kinase and Wnt/b-catenin. According to evidence from the literature currently under publication, low-level laser treatment also influences the expression of genes such as activator protein 1, nuclear factor kappa-B, and hypoxia-inducible factor, which helps to regulate cytokine levels and growth factors. Furthermore, low-level laser treatment promotes protein synthesis while also increasing cell motility and proliferation.4 It has been observed that low-level laser treatment devices promote hair growth. Nevertheless, prior literature data has not provided a clear definition or reporting of the ideal wavelength for LLLT.5

The current study evaluated red light at 630–690 nm and infrared wavelengths of 820–880 nm and 910–970 nm. The main goal of the study was to examine how participants with androgenetic alopecia would respond to low-level laser treatment administered via a helmet-like device in terms of hair growth and scalp conditions. The erythema index and sebum secretion were evaluated as secondary outcomes as well, as prior research indicated that LLLT exhibited both anti-inflammatory and sebaceous gland inhibition.

MATERIALS AND METHODS

The purpose of the current prospective clinical trial was to investigate how androgenetic alopecia patients' scalp conditions and hair development will be affected by low-level laser treatment administered via a helmet-like apparatus. As secondary results, the research also evaluated sebum secretion and erythema index. The study was conducted after approval from the relevant institutional ethical committee. The study's participants were from the Institute's Department of Dermatology. Prior to participation, informed consent, both written and verbal, was obtained from every study participant. Adult males and females between the ages of 18 and 65 who were in good health and were eager to enhance the appearance of their hair and scalp met the study's inclusion requirements.

A verified diagnosis of androgenetic alopecia based on the Norwood-Hamilton classification for men and the Ludwig classification for women. All of the individuals were instructed to keep their hair colour and style the same and to abstain from using any hair products that may impact their scalps or hair development during the research period. Subjects using any systemic or local medication known to affect hair growth, as well as those with hair disorders other than androgenetic alopecia that could affect hair growth, were excluded from the study. Neither were subjects who had used products like minoxidil, cyclosporin, finasteride, or steroids within the previous six months. The apparatus utilized in the investigation was a helmet-shaped machine with a 1.3 mW/cm2 power output at wavelengths of 630–690, 820–880, and 910–970 nm.

There were 240 diodes utilized for each wavelength specified, for a total of 720 diodes. Every participant used the gadget at home. After the therapy period of twenty minutes, the gadget shut off automatically. Changes from baseline in hair density and thickness at the vertex of the scalp at 12 and 24 weeks were the main outcomes evaluated in the research. A virtual circle with a 1 cm2 area was created on the scalp's vertex using the phototrichogram. Both the participants and the investigators rated the participants' assessments of their hair and scalp using the Global Aesthetic Improvement Scale. As seen in Table 1, information about the participants' subjective satisfaction was also acquired.

The scores on the Global Aesthetic Improvement Scale are as follows:

- 0 indicates no change,
- +1 indicates mild improvement,
- +2 indicate moderate improvement,
- +3 indicate notable improvement, and
- -2 indicates substantial deterioration.

Points on the global aesthetic rating scale are as follows: 0 indicates no change, +1 indicates mild improvement, +2 indicates moderate improvement, +3 indicates substantial improvement, and 3 indicates serious degradation. Before starting the therapy at baseline, 12 weeks, and 24 weeks, biophysical measures were obtained. A combination of

sebumeter, viscometer, hexameter, and chronometer instruments were used to measure the erythema index, sebum production, and skin melanin indices.

After three assessments of each parameter, the mean value was taken into account for the analysis. At baseline, 12 weeks, and 24 weeks, participants reported all safety evaluations, including adverse effects and vitals, which were evaluated by the examiners.

The collected data were statistically analysed using the unpaired t-test and the chi-square test, using IBM Corp.'s SPSS software version 21.0 (Armonk, NY, USA). The statistics were presented as percentage, frequency, mean, and standard deviation. An acceptable p-value for statistical significance was <0.05.

RESULTS

This research evaluated 100 participants over a 24-week period. A helmet-shaped device that emitted light for 20 minutes every day for 24 weeks at wavelengths of 630–690, 820–880, and 910–970 nm was utilised on all 100 research participants. At first, 100 patients were assessed for the research. Due to two respondents' non-compliance, the study's final sample size was reduced to 98 participants, of which 51.02% (n = 50) were male and 48.98% (n = 48) were female. The research respondents' average age was 44.3±11.7 years. Of the 48 females, 46 (95.83%) belonged to Ludwig Classification I, and 2 (4.16%) to Ludwig Classification III.

Of the 50 male individuals, 20% (n = 10) belonged to Norwood Hamilton classifications I and II, 40% (n = 20), 4% (n = 2), 8% (n = 4), and 8% (n = 4) to Norwood Hamilton classifications III, IV, V, and VI, in that order. The average hair thickness and density were 48.94±9.54 µm and 117.65±28.19/cm2, respectively. Table 1 shows the mean erythema index, melanin index, and sebum secretion on the vertex as 164.71±73.48, 297.02±76.07, and 43.59±54.83, respectively, and on the frontal area as 177.16±77.29, 281.02±76.98, and 46.49±55.27, respectively. For each study subject, the relationship between their age at enrollment and their erythema index, quantity of hair strands, and thickness of hair was evaluated.

In elderly patients, there were substantially fewer strands (p=0.001) and significantly thinner hair (p=0.001). Older participants had greater erythema indices at both the frontal and vertex regions (p=0.002). There was no correlation seen between the participants' ages and the amount of sebum production, nor between erythema and sebum secretion. The participants completed a questionnaire at each evaluation period, which included a 20-minute machine usage time. The following method was used to determine compliance:

$$\text{Compliance (\%)} = \frac{\text{actual number of trials X 100}}{\text{Total number of trials required}}$$

The total number of trials required was the number of days between the date of the first visit, which served as the date of receiving the machine, and the date of the last visit, when it was returned. During the trial, no research participants reported experiencing any significant side effects, such as allergic reactions, hair loss, or excruciating pain. Using a pre-made questionnaire, the individuals' general happiness with the gadget was also evaluated after 24 weeks of testing. Five elements on a seven-grade scale were included in the questionnaire: hair growth rate, hair thickness, number of hair strand dropouts, change in hair richness, and overall look of the scalp and hair.

Of the 98 participants, 73.47% (n=72) showed an improvement in the overall appearance of their scalps; 61.22% (n=60) showed an increase in hair richness; 65.31% (n=64) showed a decrease in the number of hair dropouts; 59.18% (n=58) showed an increase in hair thickness; and 67.35% (n=66) showed an increase in hair growth rates. 93.55% (n=92) of the patients had better hair conditions at the 12-week evaluation compared to the baseline, while 91.84% (n=90) of the respondents showed overall improvement at the 24-week assessment compared to the previous assessment.

At each visit, there was no discernible drop in the number of participants. At 12 weeks, 6.12% (n=6) of the participants had no hair changes, and at 24 weeks, 8.16% (n=8) of the subjects had no hair changes. Between baseline and 12 weeks and baseline and 24 weeks, there was an increase in hair density in the vertex area, with p-values of less than 0.01 for each time. At 12 weeks and 24 weeks, there was a substantial increase in hair thickness in the vertex area (p<0.01 and 0.01 respectively). Additionally, at 24 weeks, there was a substantial (p<0.1) drop in the vertex region of the scalp's sebum index. At every evaluation period, there was no discernible variation in the erythema and melanin indices, nevertheless.

DISCUSSION

The average age of the 98 research participants was 44.3±11.7 years. Of the 48 females, 46 (95.83%) belonged to Ludwig Classification I, and 2 (4.16%) to Ludwig Classification III. Of the 50 male individuals, 20% (n = 10) belonged to Norwood Hamilton classifications I and II, 40% (n = 20), 4% (n = 2), 8% (n = 4), and 8% (n = 4) to Norwood Hamilton classifications III, IV, V, and VI, in that order. The average hair thickness and density were 48.94±9.54 µm and 117.65±28.19/cm2, respectively. The vertex had mean erythema index of 164.71±73.48, melanin index of 297.02±76.07, and sebum secretion of 43.59±54.83; the frontal area had mean erythema index of 177.16±77.29, 281.02±76.98, and 46.49±55.27. These findings were in line with research conducted in 2013 by Pappas A et al. and Kim H et al., wherein participants experiencing hair loss were evaluated using demographic information identical to that of the current study.

The findings of the study demonstrated that there was a relationship in all of the study subjects between their age at enrollment and their levels of sebum production, erythema index, hair strand count, and hair thickness. In elderly patients, there were substantially fewer strands (p=0.001) and significantly thinner hair (p=0.001). Older participants had greater erythema indices at both the frontal and vertex regions (p=0.002).

There was no correlation seen between the participants' ages and the amount of sebum production, nor between erythema and sebum secretion. These results were in line with those of Mai-Yai Fan S et al.8 in 2018 and Chung H et al.9 in 2012, whose authors reported findings comparable to the current investigation regarding the relationship between the study subjects' enrolment age and sebum secretion, erythema index, hair strand count, and hair thickness. During the trial, no research participants reported experiencing any significant side effects, such as allergic reactions, hair loss, or excruciating pain.

Of the 98 participants, 73.47% (n=72) showed an improvement in the overall appearance of their scalps, 61.22% (n=60) showed an increase in hair richness, 65.31% (n=64) showed a decrease in the number of hair dropouts, 59.18% (n=58) showed an increase in hair thickness, and 67.35% (n=66) showed an increase in hair growth rates. The findings of Kwon HH et al. (2010) and Gui Y et al. (2011), who found no adverse effects of LT on the hair and scalp and similar subject satisfaction as in our study, were consistent with these results.

At 12 weeks following the evaluation, 93.55% (n=92) of the participants showed better hair conditions than at baseline; at 24 weeks following the assessment, 91.84% (n=90) of the subjects showed overall improvement over the previous assessment. At each visit, there was no discernible drop in the number of participants. At 12 weeks, 6.12% (n=6) of the participants had no hair changes, and at 24 weeks, 8.16% (n=8) of the subjects had no hair changes. These outcomes were consistent with those reported by Sommer AP12 in 2019 and Ferraresi C et al. in 2015, who also found that LLLT significantly improved the look of the scalp and reduced hair loss.

The study's findings also revealed that, with p-values of less than 0.01 for each, there was an increase in hair density in the vertex area between baseline and 12 weeks as well as baseline and 24 weeks. At 12 weeks and 24 weeks, there was a substantial increase in hair thickness in the vertex area ($p<0.01$ and 0.01 respectively). Additionally, at 24 weeks, there was a substantial ($p<0.1$) drop in the vertex region of the scalp's sebum index. At every evaluation period, there was no discernible variation in the erythema and melanin indices, nevertheless.

These findings correlated with the studies of Kim JE et al[14] in 2017 and Moskvin SV[15] in 2019 where authors reported that LLLT results in improved hair density with decreased melanin and sebum production and improved erythema index following the application of LLLT.

CONCLUSIONS

Within its limitations, the present study concludes that the application of a helmet-like low-level laser therapy device can help in improving the overall appearance of the hair with an increase in the density and thickening of the hair. It can also improve the condition of the scalp by decreasing the secretion of the sebum. However, future studies with larger sample sizes and longer monitoring periods are needed.

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TABLES

Characteristics	**Number (n=98)**	**Percentage (%)**
Mean age (years)	44.3±11.7	
Gender		
Females	48	48.98
Ludwig classification -I	46	95.83
Ludwig classification -II	0	0
Ludwig classification -III	2	4.16
Males	50	51.02
Norwood Hamilton classification-I	10	20
Norwood Hamilton classification-II	10	20
Norwood Hamilton classification-III	20	40
Norwood Hamilton classification-IV	2	4
Norwood Hamilton classification-V	4	8

Norwood Hamilton classification-VI	4	8
Mean hair density/cm2	117.65±28.19	
Mean hair thickness (µm)	48.94±9.54	
Vertex		
Mean Erythema index	164.71±73.48	
Mean melanin index	297.02±76.07	
Mean sebum secretion	43.59±54.83	
Frontal		
Mean Erythema index	177.16±77.29	
Mean melanin index	281.02±76.98	
Mean sebum secretion	46.49±55.27	

Table 1: Baseline data of the study participants

Compliance	**Results**
Total	
Number (n)	98
Mean ± S. D	94.50±3.19
Min-Max	83.81±97.12

Table 2: Treatment compliance in the study subjects