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ANALYZING THE EFFICACY OF LOW-LEVEL LASER TREATMENT ON SCALP HEALTH AND HAIR DEVELOPMENT

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ABSTRACT

Background: In terms of esthetics, regardless of age or gender, the way the scalp and hair look is quite important. For hair loss and scalp issues, however, a range of therapeutic approaches and medications have been recommended; nonetheless, the response to the care is still insufficient.

Aim: The current investigation sought to determine how low-level laser treatment affected scalp health and hair development.

Methods: During a 24-week period, 100 participants were evaluated for this study. A helmet-shaped device that emitted light for 20 minutes a day for 24 weeks at wavelengths of 630–690, 820–880, and 910–970 nm was utilised with all 100 research participants. 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, and 24 weeks in all research participants.

Results: According to study findings, there was a substantial increase in hair density and thickness ($p=0.01$ and <0.1, respectively) 24 weeks after treatment. 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.

Conclusion: By increasing the density and thickness of the hair, the application of a low-level laser treatment equipment that resembles a helmet can assist to improve the look of the hair overall. It can also reduce sebum secretion, which will benefit the health of the scalp.

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

INTRODUCTION

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

For many years, the profession of dermatology has used low-level laser therapy, or LLLT, to treat a variety of clinical symptoms and illnesses, such as hair loss, inflammation, discomfort, 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. Low-level laser treatment has been shown in the literature to modify the expression of genes such as activator protein 1, nuclear factor kappa-B, and hypoxia-inducible factor, which in turn serves to regulate growth factors and cytokine levels. Furthermore, low-level laser treatment promotes protein synthesis while also increasing cell motility and proliferation.There have been reports of 4 low-level laser treatment devices increasing hair growth. The ideal wavelength for LLLT, however, has not been precisely determined or documented in the data from earlier publications.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

This prospective clinical study looked at how low-level laser treatment, administered via a helmet-like device, affected the development of hair and scalp conditions in individuals suffering from androgenetic alopecia. As secondary results, the research also evaluated sebum secretion and erythema index. 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.

The apparatus utilised 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 720 diodes overall since 240 diodes were utilised for each of the wavelengths that were stated. Every participant used the equipment at their residence. 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.

Investigators and participants assessed the subjects' hair and scalp using the Global Aesthetic Improvement Scale. Additionally, information about the participants' subjective satisfaction was acquired, as Table 1 illustrates. The following are the scores on the Global Aesthetic Improvement Scale: 0 represents no change, +1 represents mild improvement, +2 represents moderate improvement, +3 represents notable improvement, and -2 represents substantial degradation.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. 3 indicates serious deterioration.

Prior to starting therapy, biophysical assessments were performed at baseline, 12 weeks, and 24 weeks. A mix of sebumeter, viscometer, hexameter, and chronometer instruments was 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. Examiners evaluated safety evaluations, such as adverse effects and vital signs, which were reported by the participants at baseline, 12 weeks, and 24 weeks.

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. A p-value of less than 0.05 was maintained for statistical significance.

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 with all 100 research participants.

The study initially screened 100 subjects. 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 (95.6%) 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 enrolment 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 formula used to assess compliance was

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

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 look of their scalpsincreased hair thickness in 59.18% of subjects (n=58), decreased hair dropout rates in 65.31% of subjects (n=64), increased hair richness in 61.22% of subjects (n=60), and increased hair growth rates in 67.35% of research participants (n=66), respectively.

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 by Pappas A et al. (2006) and Kim H et al. (2007), whose authors evaluated hair loss patients using similar demographic information as the current study.

The study's findings demonstrated that there was a relationship in each subject's case between their age at enrolment and their levels of sebum production, erythema index, hair strand count, and hair thickness. In addition to having considerably thinner hair (p=0.001), elderly participants had significantly fewer strands. Older participants had greater erythema indices in the frontal and vertex regions, with p=0.002 for each. Both erythema and sebum production did not correlate with the patients' ages or the amount of sebum secretion. The results of Mai-Yai Fan S et al.8 in 2018 and Chung H et al.9 in 2012, whose authors presented results comparable to the current study regarding the correlation between the study subjects' enrolment age and sebum secretion, erythema index, hair strand count, and hair thickness, were in line with these findings.

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. Melanin and erythema indices, however, did not significantly change at any point during the testing period. These results were consistent with research by Kim JE et al. (2014) and Moskvin SV (2015), who found that LLLT improves hair density, reduces melanin and sebum production, and improves erythema index after treatment.

CONCLUSIONS

The current study, while having several limitations, comes to the conclusion that using a low-level laser treatment equipment that resembles a helmet can assist improve the overall appearance of hair by increasing its density and thickness. Because it reduces sebum secretion, it can also help with scalp conditions. Future research is nonetheless required, preferably with bigger sample numbers and longer monitoring times.

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TABLES

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 evaluated with global esthetic improvement scale by examiner and subjects

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