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Original Research Article

A clinical study on the efficacy of minoxidil liniment in treating female pattern hair loss

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Abstract

Purpose: *To investigate the clinical effect of low and high-dose minoxidil liniment in treating female pattern hair loss.*
Methods: *A total of 280 female pattern hair loss patients admitted to the dermatology clinic of Lujiang County People's Hospital of Anhui Province, China from October 2020 to October 2021 were randomly divided into control and study groups comprising 140 patients in each group. Ludwig staging in the two groups included 35 cases of Type I, 80 cases of Type II, and 25 cases of Type III in control group; 40 cases of Type I, 74 cases of Type II, and 26 cases of Type III in study group. Control group was treated with 1 mL (7 sprays) of 2 % minoxidil liniment, twice daily for 6 months. Study group was treated with 1 mL (7 sprays) of 5 % minoxidil liniment. Efficacy of low and high-dose minoxidil liniment was determined according to the area and degree of hair loss before and after treatment, and the incidence of adverse responses was recorded.*
Results: *After treatment for 3 months, the effective rates of control and study groups were 34.3 and 41.4 %, respectively. Effective rates of control and study groups were 57.1 and 72.9 % respectively after 6 months of treatment. the effective rate of 5 % minoxidil significantly improved compared to 2 % after treatment for 6 months in Ludwig type III.*
Conclusion: *Both 2 and 5 % minoxidil liniments demonstrate clinical efficacy in female pattern hair loss in a dose-dependent manner.*

Keywords: *Minoxidil, Liniment, Female pattern hair loss*

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INTRODUCTION

Female pattern hair loss (FPHL) is characterized by diffuse alopecia without a scar. The root cause of FPHL is still unknown but it has been linked to gradually shrinking hair follicles and reduced hair numbers. The distribution of hair loss sites is regular, and most hair loss occurs in central, frontal and parietal scalp regions, also with genetic susceptibility [1].

Minoxidil is the only topical medication approved by the FDA for the treatment of androgenetic alopecia (AGA). It is believed to stimulate hair follicle growth, improve blood circulation to hair follicles, and promote hair growth [2]. However, the precise mechanism of minoxidil in treating

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the alopecia area is currently unclear. It is speculated that the opening of potassium ion channels prevents calcium ions from entering the cells, shortening the resting phase and allowing hair follicles to enter the growth phase. This speculation is difficult to prove, and there is no clear evidence and studies to show the relationship between hair follicles and adenosine triphosphate (ATP) [3]. Indeed, there is evidence suggesting that minoxidil prolongs hair follicle growth and increases the size of hair follicles. In *in vitro* studies of various skins and hair follicle cells, minoxidil promotes the production of vascular endothelial growth factor, thereby increasing blood vessels around hair follicles for better hair nourishment, all of which may be related to hair growth [4]. Minoxidil also promotes angiogenesis around hair follicles, speeding up blood flow. Recent studies have presented that minoxidil also increases the production of prostaglandin E2 by stimulating prostaglandin lactone-oxide synthase 1, thus promoting hair growth [5].

Side effects of minoxidil include pruritus, dermatitis, hirsutism, desquamation, headache, palpitation, chest pain, abdominal swelling, dizziness, etc. Since, its approval, no study has reported the efficacy and safety of 2 and 5 % minoxidil liniment in female pattern alopecia. This research investigated the efficacy and safety of 2 and 5 % minoxidil liniment in treating female pattern hair loss.

METHODS

General information

A total of 280 patients with female pattern hair loss admitted to the hair clinic of the Dermatology Department of Lujiang County People's Hospital of Anhui Province, China from October 2020 to October 2021 were selected and randomly divided into control and study groups comprising 140 patients in each group. This study was approved by the Ethics Committee of Lujiang County People's Hospital of Anhui Province (approval no. 52783521), and complied with international guidelines for human studies. Control group ranged in age from 18 to 46 years (30.45 ± 8.28 years), and the average course of the disease was 3.32 ± 1.31 years. Study group ranged in age from 18 to 50 years (31.92 ± 9.83 years), and the average course of disease of (3.42 ± 1.31) years. Ludwig staging in the two groups included 35 cases of Type I, 80 cases of Type II, and 25 cases of Type III in control group; and 40 cases of Type I, 74 cases of Type II, and 26 cases of Type III in study group. There were 71 and 73 patients with a family history of hair loss in control and study groups respectively. Parameters in both groups did not differ significantly ($p > 0.05$).

Diagnostic criteria

According to the Chinese Guidelines for Diagnosis and Remedy of Androgenic alopecia [6], all enrolled patients were consistent with FPHL.

Inclusion criteria

Patients who met the diagnostic criteria were in good mental condition, could see the doctor on time, had high medical adherence, and had voluntary consent to participate in the study.

Exclusion criteria

Pregnancy or lactation, abnormal blood pressure, cardiac insufficiency, have received hair loss therapy or used hair loss products within the last 6 months, and have known allergy to the drugs used.

Treatments

Control group was treated with 1 mL (7 sprays) of 2 % minoxidil liniment (Shanxi Ant Biopharmaceutical Co., LTD., National medicine approval number: H20020190, specification: 60 mL/bottle), twice a day for 6 months. Study group was treated with 1 mL (7 sprays) of 5 % minoxidil liniment (Shanxi Ant Biopharmaceutical Co., LTD., National medicine approval number: H20060626, specification: 60 mL/ bottle) twice daily for 6 months.

Evaluation of parameters/indices

Clinical efficacy evaluation

Patients in both groups were photographed, and effectiveness of treatment (E) was assessed based on changes in the area and severity of hair loss in the top and anterior parietal regions before and after treatment using Eq 1. Ludwig staging method was adopted, and the criteria for efficacy are as follows: -3 = obvious reduction; -2 = moderate reduction; -1 = slight reduction; 0 = no change; +1 = slight improvement; +2 = moderate improvement; +3 = obvious improvement, with higher scores indicating better outcomes.

E = (apparent cases + effective cases)/total cases …….... (1)

Adverse reaction indices

Adverse reactions such as scalp itching, hair loss, hirsutism or contact dermatitis after the use of minoxidil liniment were investigated [7].

Statistical analysis

Clinical results were all processed using statistical packages for social sciences (SPSS 21.0 software) and measurement data were expressed as (mean ± SD). Inter-group analysis was done using a t-test and analysis of variance (ANOVA). Comparison of counts was done with chi-square test and $p < 0.05$ was considered significant.

RESULTS

Clinical efficacy after 3 months of remedy

There was no significant difference in patients' data (Table 1). Comparative analysis of 3 months efficacy revealed that after 3 months of treatment, there was no statistical significance in effective rate ($p > 0.05$) (Table 2).

Clinical efficacy after 6 months of remedy

After 6 months of treatment, the effective rate of study group was significantly higher compared to control group ($p < 0.01$) (Table 3, Figure 1).

Table 1: Comparison of general information (N = 140)

Group	Age (years)	Course of disease (years)	Family history (N)	Ludwig staging (N)
Control	30.45±8.28	3.32±1.31	71	I35/II80/III25
Study	31.92±9.83	3.42±1.31	73	I40/II74/III26
***P*-value**	0.1746	0.4973	0.8110	0.7458

Table 2: Clinical efficacy after 3 months of treatment (N = 140)

Group	Apparent	Efficient	Invalid	Efficient Rate
Control	10(7.1%)	38(27.1%)	92(65.7%)	48(34.3%)
Study	13(9.3%)	45(32.1%)	82(58.9%)	58(41.4%)
χ^2				1.5181
P-value				0.2179

Table 3: Clinical efficacy after 6 months of treatment (N = 140)

Group	Apparent	Efficient	Invalid	Efficient Rate
Control	34(24.3%)	46(32.9%)	60(42.9%)	80(57.1%)
Study	46(32.9%)	56(40.0%)	38(27.1%)	102(72.9%)
χ^2				7.5981
P-value				0.0058

Figure 1: Comparison of clinical efficacy

Table 4: Efficacy of Ludwig Type I patients

Group	Duration	Efficacy							Efficient
		+3	+2	+1	0	-1	-2	-3	
Control (35)	3 months	0	5(4.3%)	15(42.9%)	15(42.9%)	0	0	0	20(57.1%)
	6 months	1(2.9%)	11(31.4%)	15(42.9%)	8(22.9%)	0	0	0	27(77.1%)
Study (40)	3 months	0	6(15.0%)	16(40.0%)	18(45.0%)	0	0	0	22(55.0%)*
	6 months	2(5.0%)	13(32.5%)	17(42.5%)	8(20.0%)	0	0	0	32(80.0%)$^{\Delta}$

Note: *$^{*}P$ > 0.05 vs. control group (χ^2 = 0.0348), $^{\Delta}P$ > 0.05 *vs.* control group treatment (χ^2 = 0.0908)

Table 5: Clinical efficacy in Ludwig Type II (N, %)

Group	Duration	Efficacy							Efficient
		+3	+2	+1	0	-1	-2	-3	
Control (80)	3 months	0	2(2.5%)	18(22.5%)	59(73.8%)	1(1.3%)	0	0	20(25.0%)
	6 months	0	18(22.5%)	24(30.0%)	37(46.3%)	1(1.3%)	0	0	42(52.5%)
Study (74)	3 months	0	2(2.7%)	19(25.7%)	52(70.3%)	1(1.3%)	0	0	21(28.4%)*
	6 months	1(1.4%)	21(28.4%)	26(35.1%)	25(33.8%)	1(1.3%)	0	0	48(64.9%)$^{\Delta}$

Note: *$^{*}P$ > 0.05 vs. control group (χ2 = 0.2246), $^{\Delta}P$ > 0.05 *vs.* control group treatment (χ^2 = 2.4199).

Table 6: Ludwig Type III 3 and 6 months of efficacy comparison (N = 140)

Group	Duration	Efficacy							Efficient
		+3	+2	+1	0	-1	-2	-3	
Control (25)	3 months	0	3(12.0%)	5(20.0%)	17(68.0%)	0	0	0	8(32.0%)
	6 months	0	4(16.0%)	7(28.0%)	14(56.0%)	0	0	0	11(44.0%)
Study (26)	3 months	0	5(19.2%)	10(38.5%)	11(42.3%)	0	0	0	15(57.7%)*
	6 months	1(3.8%)	8(30.8%)	13(50.0%)	4(15.4%)	0	0	0	22(84.7%)$^{\Delta}$

Note: *$^{*}P$ > 0.05 vs. control group (χ2 = 3.3978); $^{\Delta}P$ < 0.05 vs. control group treatment (χ^2 = 9.2062)

Table 7: Comparison of incidence of adverse reactions (N = 140)

Group	Contact dermatitis	Itching	Hair loss	Hairy	Adverse responses
Control	2(1.4%)	1(0.7%)	1(0.7%)	0	4(2.9%)
Study	3(2.1%)	2(1.4%)	3(2.1%)	1(0.7%)	9(6.4%)*
χ^2					2.0167
***P*-value**					0.1556

Note: *$^{*}P$ < 0.05 vs. control group

Efficacy of Ludwig Type I patients

After 3 and 6 months of treatment, there was no statistical significance in the effective rate (p > 0.05) (Table 4).

Efficacy of Ludwig Type II patients

After 3 and 6 months of treatment, there was no statistical significance in the effective rate (*p* > 0.05) (Table 5).

Efficacy of Ludwig Type III patients

After 3 months of treatment, there was a significant difference in effective rate (*p* < 0.05). After 6 months of treatment, the effective rate of study group was significantly higher compared to control group (*p* < *0.01*) (Table 6).

Incidence of adverse responses

There were no serious adverse reactions recorded. Furthermore, the incidence of adverse reactions was not statistically significant in two groups (*p* > 0.05).

DISCUSSION

A total of 50 % of women in the world are affected by female pattern hair loss (FPHL), while the incidence rate among Chinese women is 6 %, which is lower than that of Western countries [8]. Female pattern hair loss may be associated with genetic, hormonal, and psychological factors, but overall, androgens are considered the primary cause. Androgens such as androstenedione serve as the primary source of androgens in women. Susceptible hair follicles in the hair loss area contain specific 5α-reductase which catalyzes the conversion of androstenedione into Dihydrotestosterone (DHT) [9].

Treatment of FPHL involves the use of topical drugs, oral drugs, microneedles, low-dose laser

therapy, autologous fat transfer, platelet-rich plasma, and hair transplantation [10].

Spironolactone is a commonly used oral medication that functions by reducing the secretion of testosterone from the adrenal gland and antagonizing the binding of dihydrotestosterone (DHT) to androgen receptors. However, as spironolactone is an inefficient diuretic, blood potassium concentration should be closely monitored [11].

In this study, the effective rate of 5 % minoxidil significantly improved compared to 2 % after treatment for 6 months in Ludwig type III. In a similar study by Lucky *et al* [12], a 5 % topical minoxidil solution exhibited greater efficacy compared to 2 % over a 48-week treatment period for FPHL. Furthermore, there was no statistical significance in adverse reactions in both groups, however, incidences were higher with 5 % minoxidil solution. Minoxidil is indeed used clinically as a blood pressure medication. It stimulates sympathetic nerves and affect calcium channels. Although there is no clinical evidence, some minoxidil solution may be absorbed into the scalp skin tissue. This absorption could potentially lead to side effects such as tachycardia, water sodium retention, and postural hypotension. Therefore, in clinical use, attention should be paid to patients' blood pressure and cardiac function [13] as a possible adverse effect.

In this study, both 2 and 5 % minoxidil liniment were found to be effective for all levels of FPHL (female pattern hair loss) patients. Specifically, for Ludwig Type III patients with FPHL, there was a significant difference in response rate after 6 months of treatment compared to other Ludwig-type patients. This suggests that the efficacy of minoxidil in treating FPHL may be related to the stage of hair loss at the time of use.

Limitations of the study

Although minoxidil is already approved for clinical use, this post-clinical investigation would still require a longer treatment duration to establish the effect of long term use as well as mechanism of noticeable adverse effects since such treatment is usually applied over long duration of years by affected patients.

CONCLUSION

Minoxidil liniment are clinically efficacious in treating female pattern hair loss (FPHL). However, the clinical efficacy of 5 % is superior to 2 % minoxidil liniment. Additionally, the 5 % minoxidil liniment appears to be more efficacious in treating severe cases of FPHL.

DECLARATIONS

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None provided.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors.

Ethical Approval

This study was approved by the Ethics Committee of Lujiang County People's Hospital of Anhui Province (approval no. 52783521).

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

*Use of Artificial Intelligence/*Large Language Models

None provided.

Use of Research Reporting Tools

None provided.

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