

Determinants of Occipital Involvement in Males and Females with Pattern Hair Loss: A Retrospective Study

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How to cite this paper: Zari, S. (2024) Determinants of Occipital Involvement in Males and Females with Pattern Hair Loss: A Retrospective Study. *Journal of Cosmetics, Dermatological Sciences and Applications*, 14, 128-140.
<https://doi.org/10.4236/jcda.2024.142009>

Received: March 14, 2024

Accepted: May 19, 2024

Published: May 22, 2024

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Abstract

Background: Pattern hair loss (PHL) is the most common form of hair loss affecting both men and women. The occipital region, located at the back of the scalp, has been considered resistant to hair loss in PHL. It is often used as a donor site for hair transplantation procedures. However, evidence suggests that the occipital region may also be affected by PHL, although to a lesser extent compared to the frontal and vertex regions. **Objective:** To assess the levels and determinants of occipital involvement in PHL, focusing on gender and disease severity. Such data would enhance the comprehensive understanding of PHL progression and inform development of improved treatment strategies. **Methods:** This retrospective study involved 1993 adults (1000 males, 993 females) following for PHL at a specialized hair clinic in Jeddah, Saudi Arabia. Any patient who had hair transplantation in the past and any male who had balding areas (Hamilton-Norwood scales 4 to 7) at the initial consultation was excluded. The primary outcome was occipital involvement, defined as >10% thin hairs in the trichometry assessments of the occipital region. Additional data included patient's age, treatment status, disease severity, and other trichometry parameters. **Results:** The prevalence of occipital involvement was found to be 23.8% overall, significantly more frequent in females (35.6%) than males with early PHL (Hamilton-Norwood scales 2 and 3) (12.1%) ($p < 0.001$). The mean percentage of thin hair increased with disease severity in both males and females, though consistently higher in females. Independent factors associated with occipital involvement included females (OR = 3.62; 95% CI: 2.86 - 4.57; $p < 0.001$) and increasing disease severity (OR = 2.49; 95% CI = 1.98 - 3.12; $p < 0.001$). **Conclusion:** This study underscored the relevance of gender and disease severity in occipital involvement in PHL. Females had significantly higher rates of occipital in-

volvement, suggesting that gender differences are critical in understanding PHL progression. Future research should aim to validate these findings, with an aim to refine therapeutic and surgical approaches to improve patient outcomes.

Keywords

Pattern Hair Loss, Occipital Involvement, Gender, Trichometry, Donor Zone

1. Introduction

Male pattern hair loss (MPHL) and female PHL (FPHL) are the most common forms of hair loss, with a lifetime prevalence of 80% in males and 50% in females [1]. The disease presents as a progressive miniaturization of hair follicles in response to various genetic and hormonal factors, leading to characteristic baldness patterns [1] [2], and potentially impacting the patients' well-being and quality of life [3].

Despite considerable therapeutic advancements that enabled slowing the disease progression, the available treatments have limited efficacy in restoring hair regrowth [4]. Therefore, hair transplantation remains the ultimate option in certain cases; however, its efficacy depends on the hair density in the occipital donor area [5] [6].

The frontal region and the mid-frontal scalp are the most commonly impacted areas in MPHL and FPHL respectively [7] [8]. Nevertheless, due to further phenotypic variations, inconsistencies exist regarding the extent to which other regions of the scalp are involved. Among these are the involvements of the occipital area or other areas, which are variably reported in both MPHL and FPHL [9] [10] [11] [12]. This may have important clinical implications, notably regarding the therapeutic approach and the prognosis associated with the involvement of each area.

Following the finding that one-third of females with PHL exhibited occipital involvement in a prior study [13], this research aimed to contrast the prevalence of occipital involvement and assess the impact of disease severity in males with early-stage PHL (Hamilton-Norwood scale 2 and 3) relative to females. The comparison was limited to males with early PHL to match females with comparable hair density and cosmetic appearance. Furthermore, the study sought to elucidate the relationship between trichometric parameters in frontal and occipital regions across genders. Such data is crucial for understanding PHL progression for both genders, and enhancing treatment selection.

2. Methods

2.1. Design

This study was conducted through a retrospective analysis of patient charts from

a specialized hair clinic of the author in Jeddah, Saudi Arabia. Ethical clearance was provided by the University of Jeddah's Bioethics Committee for Scientific and Medical Research (UJ-REC-187).

2.2. Population

The target population consisted of adult females and males who sought consultation or treatment for PHL from January 2020 to January 2023. Both individuals who had never received treatment (the untreated group) and those for whom previous treatment had failed (the failed treatment group) were included. Treatment failure was defined as patients who presented to the clinic and expressed dissatisfaction with the outcomes of the previous treatment. It is important to note that only males with Norwood-Hamilton scales 2 and 3 were included in this study. However, all Sinclair scales in females were included in the study. Patients with a history of hair transplantation and males presenting with balding areas (Hamilton-Norwood scales 4 to 7) at initial consultation, thus candidates for transplantation, were excluded from the study.

2.3. Trichometric Examination

In this study, trichometry parameters of participants were determined from trichoscopic images captured using a Medicam 800 computerized video dermatoscope (FotoFinder Systems GmbH, Bad Birnbach, Germany), in conjunction with Tricholab digital image analysis (TrichoLAB, Warsaw, Poland). For each participant, an image was acquired at 20× magnification and four additional images at 70× magnification from both the frontal midline and occipital midline regions. This standardized image acquisition protocol ensured consistent and reliable measurements of trichometry parameters throughout the study population.

2.4. Outcome Definition

The criteria for occipital involvement was defined as having more than 10% of thin hairs (less than 0.03 mm), as per the third major criterion outlined in the classification of PHL proposed by Rakowska *et al.* [14].

2.5. Data Collection

Data was collected using a pre-formatted Excel spreadsheet. Collected data included: the patient's age; treatment status (whether never treated or post treatment failure); severity of the disease, determined by the trichoscopy-derived Sinclair scale (TDSS) in the frontal region; baseline trichometry parameters by scalp region, which were categorized into positive and negative parameters. Positive parameters included hair density (N/cm²), average hair shaft thickness (AHST, μm), percentage of thick hair, number of follicular units (NFU), triple follicular units, and cumulative hair thickness (CHT, mm/cm²). Negative parameters included percentage of thin and medium hair; and the percentage distribution of single and double follicular units.

2.6. Statistical Methods

Statistical analysis was performed using SPSS version 21 for Windows (IBM SPSS) and Jamovi Version 2.3 for Windows (The Jamovi Project, 2022), retrieved from <https://www.jamovi.org>. Across-gender comparisons used chi square test for categorical variables and independent t-test for continuous variables, with calculation of the effect size using Cohen's D statistics. Independent factors associated with occipital involvement were analyzed using multivariate logistic regression. To analyze the correlation of occipital involvement with disease severity, the study population was divided into 8 levels of disease severity, by binning TDSS in the frontal region into standard deviation intervals, from <-3 SD to $>+3$ SD. Within each severity level, the prevalence of occipital involvement was compared between male and female groups using Chi square or Fisher's exact test, as applicable. Additionally, Two-Way ANOVA was used to compare the percentage of thin hair between males and females, within each level of severity; results are plotted as means and 95% confidence intervals (95% CI). The statistical significance level was set at $p < 0.05$.

3. Results

3.1. Demographic and Baseline Data

The total population consisted of 1993 individuals, with 1000 males and 993 females. The mean age of the total population was 32.81 years (SD = 9.59). When comparing the genders, males (mean = 30.98 [SD = 7.15] years) were younger than females (35.66 [11.25] years), and the difference was statistically significant ($p < 0.001$). Among the total population, 31.6% ($n = 630$) received previous treatment for PHL, with a slightly higher percentage among females (34.1%) than males (29.1%) ($p = 0.016$) (Table 1).

3.2. Prevalence and Cross Gender Comparison of Occipital Involvement

The prevalence of occipital involvement, defined as a percentage of thin hair in

Table 1. Main study outcomes.

Parameter	Level	Total population (N = 1993)		Males (N = 1000)		Females (N = 993)		p-value
		n	%	N	%	n	%	
Previous treatment for AGA	No	1363	68.4	709	70.9	654	65.9	0.016*
	Yes	630	31.6	291	29.1	339	34.1	
% Thin hair in frontal region	<10%	576	28.9	342	34.2	234	23.6	<0.001*
	$\geq 10\%$	1417	71.1	658	65.8	759	76.4	
% Thin hair in occipital region	<10%	1518	76.2	879	87.9	639	64.4	<0.001*
	$\geq 10\%$ §	475	23.8	121	12.1	354	35.6	

AGA: Androgenetic alopecia; §: occipital involvement.

the occipital area $\geq 10\%$ was 23.8% (95% CI: 22.0% - 25.8%). Comparing genders, occipital involvement was significantly more frequent among females (35.6% vs 12.1%) compared to males with Hamilton-Norwood scales 2 and 3 ($p < 0.001$) (Table 1). This corresponds to an odds-ratio (OR) of occipital involvement of 4.02 (95% CI: 3.2, 5.07) among females with reference to males.

3.3. Trichometry Findings in Males versus Females

We compared trichometry findings between males and females in the frontal and occipital regions. Table 2 presents the mean values, standard deviations (SD),

Table 2. Difference between males and females in trichometry findings in frontal and occipital regions.

Parameter	Scalp region	Males (N = 1000)		Females (N = 993)		p-value	Effect size (Cohen's D)
		Mean	SD	Mean	SD		
<i>Positive parameters</i>							
Hair density (N/cm ²)	Frontal	205.26	43.63	185.08	43.54	<0.001*	0.46
	Occipital	187.43	36.89	184.39	42.53	0.089	0.08
AHST (μm)	Frontal	52.03	9.33	53.14	10.04	0.010*	0.11
	Occipital	68.58	9.25	59.69	9.28	<0.001*	0.96
% thick hairs	Frontal	51.22	19.31	52.57	18.11	0.106	0.07
	Occipital	78.80	11.95	66.45	16.09	<0.001*	0.87
Triple follicular units	Frontal	36.92	12.57	28.55	13.70	<0.001*	0.64
	Occipital	47.52	13.11	40.60	14.36	<0.001*	0.50
CHT	Frontal	10.58	2.47	9.77	2.77	<0.001*	0.31
	Occipital	12.79	2.64	10.93	2.65	<0.001*	0.70
NFU	Frontal	90.93	13.75	90.30	16.22	0.354	0.04
	Occipital	74.01	12.31	77.86	13.91	<0.001*	0.29
<i>Negative parameters§</i>							
% thin hairs	Frontal	16.07	11.72	18.62	11.68	<0.001*	0.22
	Occipital	4.95	5.01	8.70	7.61	<0.001*	0.58
% mid hairs	Frontal	32.70	12.54	28.74	11.48	<0.001*	0.33
	Occipital	16.12	8.60	24.77	11.35	<0.001*	0.86
Single follicular units	Frontal	26.62	10.41	33.07	13.09	<0.001*	0.55
	Occipital	17.49	7.86	23.03	11.05	<0.001*	0.58
TDSS	Frontal	2.35	0.42	2.51	0.51	<0.001*	0.33
	Occipital	2.02	0.35	2.30	0.44	<0.001*	0.72

AHST: Average Hair Shaft Thickness; CHU: Cumulative Hair Thickness; NFU: Number of Follicular Units; TDSS: Trichoscopy-DERIVED SINCLAIR Scale. § Negative parameters are those where higher values correspond to adverse patient outcome. Effect size interpretation: Small (Cohen's $d \geq 0.2$), medium (≥ 0.5), large (≥ 0.8).

p-values, and effect sizes (Cohen's D) for each parameter. In the frontal region, females exhibited a poorer trichometry profile, compared to males, considering several parameters. This includes fewer triple follicular units, a lower CHT, and higher percentages of thin hairs and single follicular units. Nonetheless, both AHST and % thick hairs were preserved among females compared to males.

Regarding the occipital region, there were several significant differences between the two genders with large effect size, most of them had disadvantages to females. Regarding positive parameters, AHST (mean = 68.58 vs 59.69; Cohen's D = 0.96), % thick hairs (78.80 vs 66.45; Cohen's D = 0.87), triple follicular units (47.52 vs 40.60; Cohen's D = 0.50), and CHT (12.79 vs 10.93; Cohen's D = 0.70) were significantly higher in males compared to females, respectively. Regarding negative parameters, all were higher among females than males including % thin hairs (8.70 vs 4.95; Cohen's D = 0.58), % mid hairs (24.77 vs 16.12; Cohen's D = 0.86), single follicular units (23.03 vs 17.49; Cohen's D = 0.58), and TDSS (2.30 vs 2.02; Cohen's D = 0.72).

3.4. Association of Occipital Involvement with Disease Severity

We divided the total population into eight levels of disease severity, by binning TDSS in the frontal region into standard deviation intervals, from <-3 SD to $>+3$ SD. The percentage of occipital thin hair increases with the level of disease severity in both genders (Two-Way ANOVA: severity effect: F statistics = 18.41, $p < 0.001$). Furthermore, at all levels of disease severity, the mean % thin hair was higher among females than males (gender effect: F = 12.74, $p < 0.001$). The multifactorial model showed a significant effect for gender severity (F = 4.98, $p < 0.001$) (Figure 1).

Furthermore, the prevalence of occipital involvement increases with the level of disease severity in both genders, but is consistently higher in females than males ($p < 0.05$) (Table 3).

Table 3. Frequency of occipital involvement by disease severity level in males versus females.

Severity level (TDSS in frontal)	N		Occipital involvement, %		
	Male	Female	Male	Female	p-value
-3 SD (1.02 - 1.48)	5	4	0.0	0.0	-
-2 SD (1.49 - 1.96)	148	130	5.4	19.2	0.001*
1 SD (1.97 - 2.43)	478	338	10.3	24.6	<0.001*
+1 SD (2.44 - 2.90)	290	356	17.2	46.6	<0.001*
+2 SD (2.91 - 3.38)	61	97	21.3	50.5	<0.001*
+3 SD (3.39 - 3.85)	14	59	7.1	49.2	0.005* ^F
>+3 SD	4	9	0.0	22.2	1.000* ^F
Total	1000	993	12.1	35.6	<0.001*

SD: Standard deviation; *Statistically significant result; ^F: Fisher's exact test.

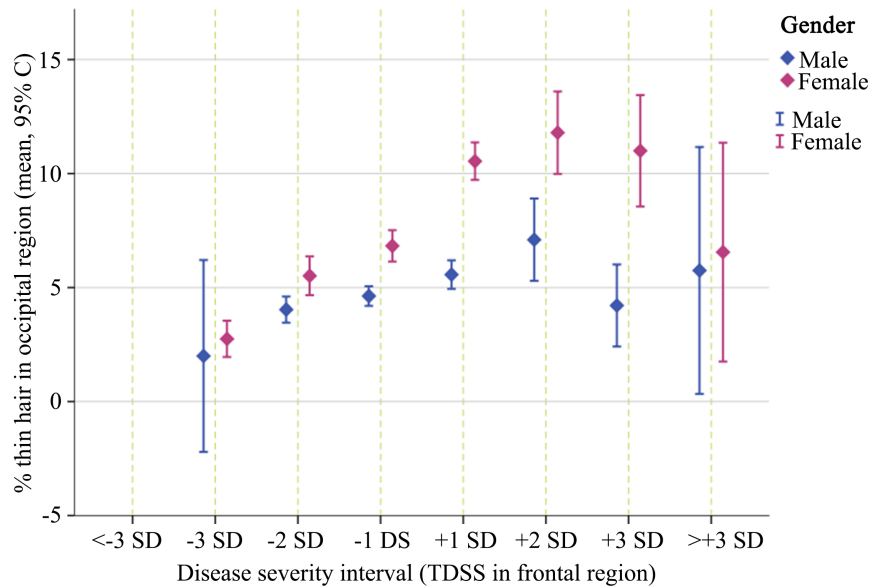


Figure 1. Levels of occipital thin hair by disease severity level in male and female patients with pattern hair loss. Caption: The figure illustrates the mean (95% CI) of % thin hairs in males (blue) versus females (pink), stratified by levels of disease severity based on binning TDSS in the frontal region into standard deviation intervals ranging from <-3 SD to >+3 SD. Two-way ANOVA analysis demonstrated the significant effects of severity level (F statistics = 18.41, $p < 0.001$), gender (F = 12.74, $p < 0.001$), and the interaction between gender and severity (F = 4.98, $p < 0.001$). This indicates that disease severity and female gender exert an independent and cumulative effect on occipital involvement.

3.5. Independent Factors of Occipital Involvement

Females have a 3.62-fold risk of having occipital involvement independent of the disease severity with reference to males (OR = 3.62; 95% CI: 2.86 - 4.57). For every one increment in TDSS in the frontal region, the likelihood of occipital involvement increases by 2.49-fold (OR = 2.71; 95% CI = 1.98 - 3.12). The multivariate model explains 10.5% of the variance of the outcome variable (occipital involvement) (Table 4). Although not sensitive (sensitivity = 11.6%), this model is highly specific (specificity = 96.6%).

4. Discussion

4.1. Summary of Findings

Understanding occipital involvement in PHL is of utmost importance as it not only sheds light on the disease progression and severity, but also directly impacts the feasibility and success of hair transplant procedures due to the compromise of the donor zone in the occipital area.

The present study provided strong evidence of the importance of occipital involvement in PHL, among a large cohort of 1993 patients. The prevalence of occipital involvement was 23.8%, with a three-fold occurrence in females (35.6%) compared to males (12.1%). Trichometry in the occipital region revealed further significant gender disparities, with females showing poorer outcomes than males

Table 4. Independent factors of occipital involvement (multivariate logistic regression).

Predictor	Level	OR	95% CI		p-value
Gender	Female	3.62	2.86	4.57	<0.001*
Previously treated	Yes	0.93	0.73	1.17	0.517
Disease severity in frontal region	TDSS unit	2.49	1.98	3.12	<0.001*

The model explains 10.5% of the outcome variance (Cox & Snell R square = 0.105).

in key parameters like AHST, % thick hairs, triple follicular units, and CHT, as well as % thin hairs, single follicular units, and derived Sinclair grade. By stratifying the population into levels of severity, the prevalence of occipital involvement increased with disease severity in both genders, but remained consistently higher in females. Predictive equations, using multivariate linear regression models, demonstrated the relationship between the occipital and frontal regions for several parameters. In terms of independent factors, females had a 3.62-fold risk of occipital involvement compared to males, independent of disease severity, while each increment in TDSS in the frontal region increased the likelihood of occipital involvement by 2.49-fold.

4.2. Occipital Involvement across Genders

The present study showed, in a large sample size, that the occipital scalp is substantially more involved in females than males with PHL. This difference concerned several parameters mainly hair shaft thickness, percentage of thin hairs and single follicular units.

There are major differences between FPHL and male AGA, both from clinical and pathophysiological perspectives. Clinically, male AGA is described according to Hamilton-Norwoods classification. It begins with a recession of the fronto-temporal hairline, followed by an associated thinning of the vertex and the mid-frontal scalp. This may progress to complete balding of these scalp areas, while the occipital region remains preserved even in advanced cases [15]. On the other hand, FPHL constitutes a hair thinning process that first involves the mid-frontal region while preserving the frontal hair line. This thinning progressively intensifies while diffusing to other scalp regions, without inducing complete baldness areas [16] [17]. In addition to the diffuse thinning process, there is an accentuation in the central line, opening into a triangle with its base at the anterior hairline (Christmas tree pattern) [18].

While the current state of knowledge indicates the contribution of genetics, hormones, and environmental factors in PHL, the exact pathogenic mechanisms in male and female forms are yet to be elucidated [19]. Prior studies have demonstrated a reduced concentration of androgen receptors and the enzymes 5 α -reductase type I and II in the occipital versus the frontal scalp regions of individuals with androgenetic alopecia. These enzymes are crucial for the conversion of testosterone to dihydrotestosterone. Furthermore, an elevated presence

of cytochrome P-450 aromatase was found in the occipital hair follicles, suggesting an accelerated local conversion of androgens to estrogens [20]. Altogether, these observations indicate that occipital hair follicles may have diminished androgen-responsive activity, which limits androgen-induced hair thinning in androgenetic alopecia [12] [21]. Nonetheless, these mechanisms probably play a more important role in male androgenetic alopecia, owing to the predominant role of androgens [22]. This suggests the hypothesis of a distinct pathological pathway for occipital involvement in FPHL.

4.3. Gender-Specific Susceptibility

No further studies have assessed the occipital or other scalp regions in FPHL versus MPHL. Nevertheless, a plethora of evidence exists supporting the specific female susceptibility for diffuse involvement of FPHL. A study involving 261 Chinese women with FPHL showed diffuse hair miniaturization along with decreased hair densities, terminal hair percentages, hair follicular unit density, and mean hair diameter across all areas of the scalp [9]. Another study by Rojhirunsakool and Suchonwanit, FPHL was associated with significant decrease in hair density and increased percentage of miniaturized hair, compared to women without FPHL. Besides, authors observed that hair density gradually decreased from the midscalp to the parietal regions even in normal women [10]. This observation suggests that different scalp areas in women present a baseline susceptibility to hair miniaturization, which may be exacerbated in case of FPHL.

In males with early PHL Hamilton-Norwood scales 2 and 3, we observed that 12.1% of males with AGA had occipital involvement. In advanced MPHL stages (Hamilton-Norwood scales 4 to 7), a greater incidence of occipital involvement is anticipated. Despite the common understanding that the occipital scalp is unaffected in male AGA, occipital scalp biopsy specimens from affected men showed significant abnormalities compared to unaffected men. These abnormalities included decrease in total hair follicles, terminal hair follicles, follicular units, and terminal to vellus ratio and increase in follicular stela [12]. These findings indicate that AGA can impact the occipital region in men, especially in advanced stages of the disease.

These findings have significant implications for hair transplantation procedures, as they provide insights into regional differences in hair density and susceptibility to miniaturization. Knowledge of these patterns can guide the selection of hair transplantation candidates, ensuring optimal outcomes and patient satisfaction. It is crucial to consider the miniaturization status of the donor site, as extracting follicles from areas prone to miniaturization in the future may compromise the effectiveness of the hair transplantation [23]. Therefore, careful donor site selection and preoperative measurements of miniaturized hairs in the donor area should be performed in all individuals undergoing hair transplantation [23] [24]. Rassman and Carson described the safe donor area with specific boundaries, including a superior vertical boundary above the external acoustic

meatus, a 2-cm superior boundary above the helical rim, and a slightly controversial inferior boundary [25]. The presence of miniaturization in the occipital donor area poses a significant challenge to hair transplantation, compromising its effectiveness [23] [24]. While alternative donor sites from other parts of the body are available for hirsute men, such options are limited for females [26]. Hence, occipital hair miniaturization in FPHL presents a major limitation for hair transplantation in female patients [27]. For females and younger males with AGA, it is advisable to prioritize nonsurgical interventions over transplantation to enhance and preserve the existing hair.

4.4. Association of Occipital Involvement with Disease Severity

The second important observation from the present study is the increased risk of occipital involvement with the disease severity, and this was observed in both males and females. This is consistent with observations by Chen *et al.*, showing a gradual decrease in occipital hair density and hair shaft diameter with the disease severity in both men and women with FPHL. This was associated with a gradual increase in vellus hair ratio and single-follicle unit ratio [26]. In males, Khunkhet *et al.* observed that the extent of occipital involvement was positively associated with the disease duration and severity, as indicated by the Hamilton-Norwood stage [12].

4.5. Limitations and Future Directions

This study has some limitations that should be considered in interpreting the findings and planning future research.

Firstly, it lacked certain essential clinical data, including disease duration, hormonal status, genetic markers, and lifestyle factors. Additionally, information on other diseases that might influence hair miniaturization, disease progression, and occipital involvement was not collected. This limits the comprehensiveness and accuracy of the analyses, and these factors should be included in future research to provide thorough understanding of PHL.

Secondly, the cross-sectional design limits our ability to establish a causal relationship between female gender and occipital involvement. Future longitudinal or prospective cohort studies are warranted to establish such causality and analyze the gender-specific kinetics of hair parameters in different scalp areas.

Thirdly, the study included females with PHL at all stages but limited male participants to early AGA (Hamilton-Norwood scales 2 and 3). The reasoning for that is that these stages retain sufficient hair for trichometric analysis across all scalp areas, unlike more advanced stages in males where baldness impedes such examination.

Lastly, the absence of histological data from scalp biopsies is another limitation. Future studies could benefit from including histological analysis to explore cellular and molecular differences between the frontal and occipital scalp regions, thereby enriching the understanding of pathological mechanisms.

Despite these limitations, the findings of the current study significantly contribute to our understanding of PHL. They highlight the necessity of a comprehensive assessment of clinical and phenotypic parameters for developing tailored management strategies, particularly to enhance patient outcomes in hair transplantation.

5. Conclusions

This study demonstrated the significant involvement of the occipital region in PHL, with a higher prevalence among females (35.6%) compared to males with early AGA (12.1%) (Hamilton-Norwood scales 2 and 3). The notable gender-based disparities in occipital involvement underscore the significant differences in hair patterns between genders under both physiological and pathological conditions. Furthermore, we demonstrated a clear correlation between PHL disease severity and the degree of occipital involvement, in both males and females, indicating that this area is not always preserved as traditionally assumed, particularly in advanced stages of the disease.

These findings have important implications for hair transplantation procedures. A better understanding of these regional differences in hair density and gender-specific susceptibility to miniaturization can guide the selection of the most appropriate candidates for hair transplantation. The selection process should take into account not only the current state of hair thinning or degree of miniaturization in the occipital donor area, but also the potential for future progression. Regardless of the patient's eligibility for hair transplantation, nonsurgical treatments should be prioritized to conserve the existing hair.

Acknowledgements

Author thanks Dr. Mohamed Amine Haireche for his support in analyzing the data of this study.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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