The Efficacy of Platelet-Rich Plasma in the Treatment of Androgenetic Alopecia: A Pilot Study

Celine Valerie and Jitlada Meephansan*

Department of Dermatology, Chulabhorn International College of Medicine, Thammasat University, Pathum Thani 12000, Thailand
*Corresponding author, E-mail: kae_mdcu@yahoo.com

Abstract

Androgenetic alopecia (AGA) is a chronic patterned hair loss condition characterized by progressive follicular miniaturization and gradual replacement of terminal hairs with thinner vellus-like hairs, leading to reduced scalp hair density, visible scalp thinning, and psychosocial distress. Platelet-rich plasma (PRP) has emerged as a regenerative therapeutic option because of its high concentration of autologous growth factors that may enhance hair follicle activity and promote tissue remodeling within the scalp microenvironment. This prospective single-arm pilot interventional study aimed to evaluate the clinical efficacy and safety of PRP therapy in patients with mild AGA using objective trichoscopic parameters. Mild AGA was defined according to established clinical staging systems, including Hamilton–Norwood stage I in men and Ludwig stage I in women. Nine patients with clinically diagnosed mild AGA received three sessions of intradermal PRP injections administered at four-week intervals to predefined scalp areas. Objective outcome measures included total hair density, hair subtype distribution, the vellus-to-terminal hair ratio, and mean hair shaft diameter, assessed using standardized trichoscopic imaging at baseline and after each treatment session. Safety monitoring included documentation of treatment-related adverse events such as injection-site pain, transient scalp edema, infection, and post-procedural hair shedding.

PRP therapy resulted in a statistically significant increase in hair density from 169 ± 28 hairs/cm² at baseline to 185.67 ± 25.61 hairs/cm² after the second treatment session ($p = 0.005$), with sustained elevation after the third session. The early treatment phases were characterized by a transient increase in vellus hair counts and a temporary reduction in mean hair shaft diameter, while changes in terminal hair counts and the vellus-to-terminal hair ratio did not reach statistical significance. No serious adverse events were observed. These preliminary findings suggest that PRP therapy may promote early follicular activation and measurable improvement in hair density in patients with mild androgenetic alopecia, indicating potential benefit as a regenerative therapeutic approach for early-stage disease. However, larger randomized controlled studies with longer follow-up are required to confirm long-term clinical efficacy.

Keywords: *Platelet-rich plasma, Androgenetic alopecia, Hair Growth, Hair density*

1. Introduction

Androgenetic alopecia (AGA), commonly referred to as male and female pattern hair loss, is the most prevalent cause of progressive hair thinning worldwide, affecting up to 80% of men and 50% of women during their lifetime (Piraccini & Alessandrini, 2014; Lolli et al., 2017). The condition is characterized by progressive follicular miniaturization, shortening of the anagen phase, and prolongation of the telogen phase, ultimately leading to reduced hair density and visible scalp thinning.

Hamilton (1951) first described the patterned distribution of hair loss and its association with androgen activity. Subsequent studies have demonstrated that dihydrotestosterone (DHT) plays a central role in the pathogenesis of AGA by altering dermal papilla cell function and disrupting normal hair follicle cycling (Randall, 2008). Over time, terminal hairs progressively transform into vellus-like hairs, resulting in gradual thinning of scalp hair.

Current first-line therapies for AGA include topical minoxidil and oral finasteride; however, treatment responses are variable and require long-term adherence, with potential local and systemic adverse

effects (Rogers & Avram, 2008; Kelly et al., 2016). These limitations have stimulated increasing interest in regenerative therapeutic strategies that aim to restore hair follicle function rather than solely inhibit androgen-mediated pathways. Among these approaches, platelet-rich plasma (PRP) has gained considerable attention as an autologous biologic therapy capable of enhancing follicular activity and promoting hair regrowth through the release of growth factors involved in angiogenesis, cellular proliferation, and tissue remodeling.

PRP is defined as a plasma fraction enriched with platelets and bioactive molecules, including platelet-derived growth factor, vascular endothelial growth factor, and insulin-like growth factor-1, which play key roles in tissue repair and follicular regeneration (Gentile et al., 2015; Kramer et al., 2018). Experimental and clinical evidence indicate that platelet-rich plasma (PRP) may enhance dermal papilla cell activity, facilitate the transition of hair follicles into the anagen phase, and improve hair density in patients with androgenetic alopecia (Gentile et al., 2015). Supporting this, Cervelli et al. (2014) demonstrated that autologous activated PRP (AA-PRP) injections resulted in significant increases in hair density and follicular proliferation, accompanied by histomorphometric findings of increased epidermal thickness and perifollicular vascularization. These observations underscore the role of platelet-derived growth factors in modulating the follicular microenvironment and promoting hair regeneration. Furthermore, Alves and Grimalt (2018) reported additional clinical benefits, including increased hair thickness and reduced hair shedding following PRP therapy.

Despite these promising findings, significant heterogeneity in PRP preparation protocols, treatment schedules, and outcome assessment methods across studies has resulted in inconsistent clinical evidence and limited comparability among results. The lack of standardized evaluation approaches remains a key challenge in determining the true therapeutic efficacy of PRP for androgenetic alopecia.

Therefore, this prospective single-arm pilot study aimed to evaluate the clinical efficacy of PRP therapy in patients with mild androgenetic alopecia using a standardized treatment protocol and objective trichoscopic outcome measures. Longitudinal changes in hair density, hair shaft diameter, and follicular subtype distribution were assessed throughout the treatment period.

2. Objectives

This study aimed to evaluate the clinical efficacy of platelet-rich plasma (PRP) therapy in patients with mild androgenetic alopecia. The primary endpoint was the change in hair density from baseline to three months after treatment, assessed using standardized trichoscopic imaging. Secondary outcomes included changes in hair shaft diameter, follicular subtype distribution, and the vellus-to-terminal hair ratio.

3. Materials and Methods

3.1 Study Design

This study was conducted as a prospective single-arm pre–post interventional pilot study. Clinical outcomes were evaluated by comparing baseline measurements with those obtained after completion of the platelet-rich plasma (PRP) treatment protocol. The primary endpoint was the change in hair density from baseline to three months after treatment.

3.2 Study Population

Patients aged 18 years and older with a clinical diagnosis of androgenetic alopecia (AGA) were enrolled. Mild AGA was defined according to established clinical staging systems, including Hamilton–Norwood stage I in male patients and Ludwig stage I in female patients. Exclusion criteria included active scalp infection, bleeding disorders, pregnancy, anticoagulant use, and previous hair restoration procedures. All participants provided written informed consent prior to enrollment.

3.3 PRP Preparation and Treatment Protocol

Autologous PRP was prepared from peripheral venous blood using a standardized centrifugation technique. Approximately 20 mL of whole blood was collected into anticoagulant-containing tubes (sodium

citrate) and subjected to single-spin centrifuged at 3,500 rpm (≈1,100 g) for 5 minutes to separate plasma components. The platelet-rich fraction was collected and used for treatment without exogenous activation.

The PRP was injected intradermally into affected scalp areas using multiple small injections distributed evenly across the treatment area. Injections were performed using a 30-gauge needle, with approximately 0.05–0.1 mL of PRP per injection point, spaced about 1 cm apart across the scalp. Each participant received three treatment sessions at four-week intervals. No additional hair growth therapies were initiated during the study period.

3.4 Outcome Measurement

Clinical and trichoscopic evaluations were performed at baseline and at follow-up visits after each PRP treatment session. Standardized digital trichoscopy was used to assess objective hair parameters within predefined scalp regions. Trichoscopic images were obtained using a Dino-Lite digital dermoscope at ×60 magnification within a defined circular measurement area (radius 2 mm) to ensure consistent evaluation across time points.

Outcome measurements included total hair density (hairs/cm²), vellus hair count, intermediate hair count, terminal hair count, vellus-to-terminal hair ratio, and mean hair shaft diameter (μm). Hair density and follicular subtype distribution were determined using digital trichoscopic analysis within the defined measurement area. Mean hair shaft diameter was calculated from multiple hair shafts within the evaluation field to provide a representative estimate of hair thickness.

3.5 Statistical analysis

Statistical analyses were performed using descriptive and inferential methods. Continuous variables, including hair density and mean hair shaft diameter, were expressed as mean ± standard deviation (SD). Hair subtype counts and the vellus-to-terminal hair ratio were summarized across study time points.

Changes in hair parameters over time (baseline, after the first, second, and third PRP sessions) were analyzed using repeated-measures analysis of variance (ANOVA) to evaluate within-subject differences. A p-value < 0.05 was considered statistically significant. Given the exploratory nature of this pilot study and the small sample size, the analysis primarily focused on identifying longitudinal trends.

Statistical analyses were performed using IBM SPSS Statistics (IBM Corp., Armonk, NY, USA).

4. Results and Discussion

Baseline Demographic Characteristics

Baseline demographic and clinical characteristics of the participants are summarized in Table 1. The study included nine patients with androgenetic alopecia, consisting of six female (67%) and three male (33%) participants, with a mean age of 39.11 ± 9.32 years (range 27–55 years). The mean duration of androgenetic alopecia was 3.44 ± 1.67 years, and 67% of participants reported a family history of the condition.

None of the participants had previously used topical minoxidil, oral finasteride, or undergone procedural treatments for androgenetic alopecia. Baseline trichoscopic evaluation demonstrated features consistent with early follicular miniaturization. All participants were classified as having mild androgenetic alopecia, corresponding to Ludwig stage I in female participants and Hamilton–Norwood stage I in male participants.

Table 1 Baseline demographic and clinical characteristics of study participants (n = 9)

Characteristic	Category	Value (%) N = 9
Sex	Female	6 (66.7)
	Male	3 (33.3)
Age (years)	Mean ± SD	39.11 ± 9.32
	Range	27–55
Underlying disease	No	9 (100%)
Current Medication	No	9 (100%)

Table 1 Cont.

Characteristic	Category	Value (%) N = 9
Duration of Androgenetic Alopecia	Mean ± SD	3.44 ± 1.67
	Range	1–6
Family history of Androgenetic Alopecia	No	3 (33.3 %)
	Yes	6 (66.7 %)
The previous standard treatment of AGA (Topical Minoxidil, Oral finasteride)	No	9 (100%)
Androgenetic alopecia staging	FPHL grade 1	6 (66.7 %)
	MPHL grade 1	3 (33.3 %)

Data are presented as mean ± standard deviation or number (percentage), as appropriate.

Table 2 Changes in hair density (hairs/cm²) across study time points

Timeline	Mean ± SD.	Mean difference (95%CI)	*p*-value
Baseline	169 ± 28.07	Reference	-
1mo after 1st PRP	183 ± 28.84	14 (1.67, 26.33)	0.026*
1mo after 2nd PRP	185.67 ± 25.61	16.67 (4.98, 28.35)	0.005*
1mo after 3rd PRP	182.89 ± 30.37	13.89 (5.04, 22.74)	0.002*

Table 3 Changes in vellus hair counts within the trichoscopic evaluation area (radius 2 mm)

Timeline	Mean ± SD.	Mean difference (95%CI)	*p*-value
Baseline	3.56 ± 2.35	Reference	-
1mo after 1st PRP	5.22 ± 2.33	1.67 (0.32, 3.01)	0.015*
1mo after 2nd PRP	5.33 ± 2.45	1.78 (0.87, 2.69)	<0.001*
1mo after 3rd PRP	4.22 ± 2.17	0.67 (-0.37, 1.7)	0.206

Table 4 Changes in intermediate hair counts within the trichoscopic evaluation area (radius 2 mm)

Timeline	Mean ± SD.	Mean difference (95%CI)	*p*-value
Baseline	8.67 ± 3.87	Reference	-
1mo after 1st PRP	8.89 ± 4.11	0.22 (-1.53, 1.97)	0.804
1mo after 2nd PRP	8.22 ± 3.56	-0.44 (-2.3, 1.41)	0.638
1mo after 3rd PRP	7.89 ± 3.48	-0.78 (-2.56, 1)	0.392

Table 5 Changes in terminal hair counts within the trichoscopic evaluation area (radius 2 mm)

Timeline	Mean ± SD.	Mean difference (95%CI)	*p*-value
Baseline	9 ± 3.2	Reference	-
1mo after 1st PRP	9 ± 4.69	0 (-2.14, 2.14)	1
1mo after 2nd PRP	9.78 ± 4.27	0.78 (-1.12, 2.68)	0.422
1mo after 3rd PRP	10.78 ± 4.27	1.78 (-0.03, 3.59)	0.055

Table 6 Changes in vellus-to-terminal hair ratio

Timeline	Mean ± SD.	Mean difference (95%CI)	*p*-value
Baseline	0.57 ± 0.61	Reference	-
1mo after 1st PRP	0.85 ± 0.77	0.28 (-0.15, 0.72)	0.204
1mo after 2nd PRP	1.16 ± 1.84	0.59 (-0.26, 1.43)	0.172
1mo after 3rd PRP	0.57 ± 0.59	0 (-0.15, 0.15)	0.988

Table 7 Changes in mean hair shaft diameter (μm)

Timeline	Mean ± SD.	Mean difference (95%CI)	*p*-value
Baseline	57.58 ± 6.99	Reference	-
1mo after 1st PRP	50.5 ± 9.2	-7.08 (-11.59, -2.57)	0.002*
1mo after 2nd PRP	53.5 ± 9.1	-4.08 (-6.7, -1.45)	0.002*
1mo after 3rd PRP	55.16 ± 7.83	-2.42 (-5.46, 0.62)	0.118

Data are presented as mean ± standard deviation. Mean differences and 95% confidence intervals were derived from repeated measures ANOVA with baseline as the reference. *p < 0.05 indicates statistical significance.

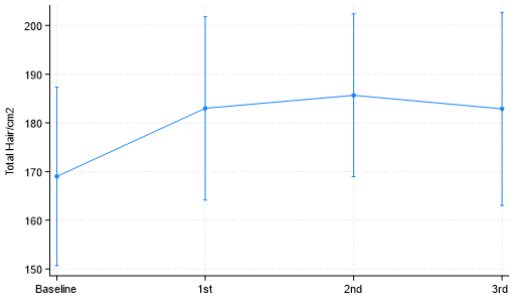

Figure 1 Hair density (hairs/cm²)

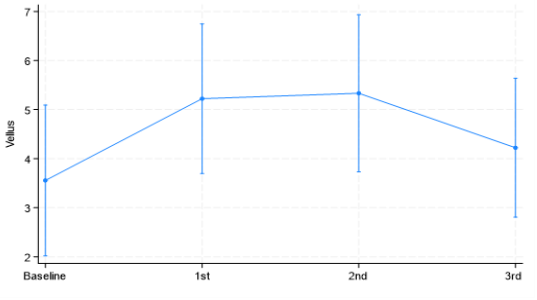

Figure 2 Vellus hair count (radius 2 mm)

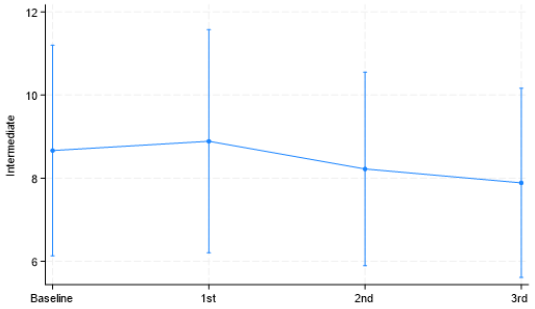

Figure 3 Intermediate hair count (radius 2 mm)

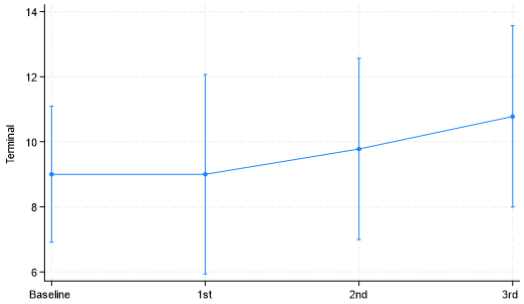

Figure 4 Terminal hair count (radius 2 mm)

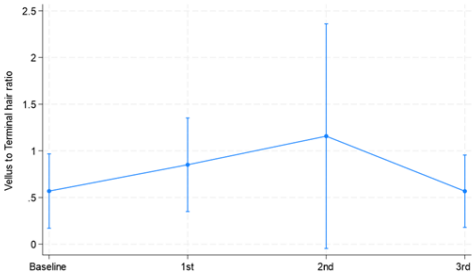

Figure 5 Vellus to Terminal Hair ratio

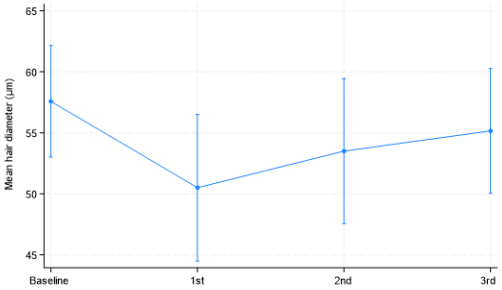

Figure 6 Mean hair diameter (μm)

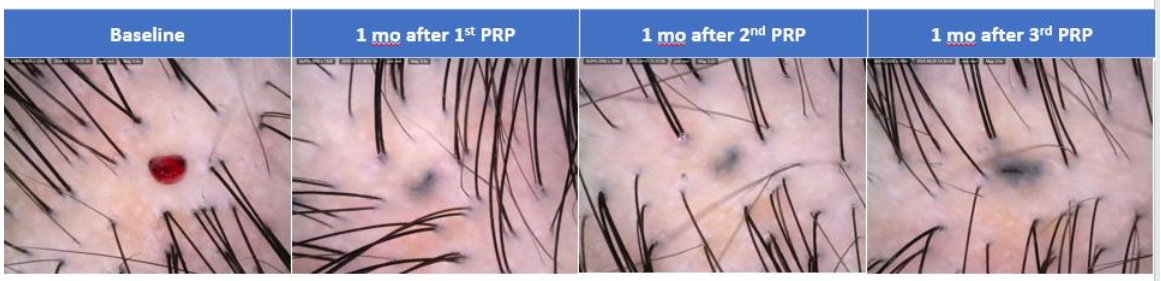

Figure 7 Representative trichoscopic images of the same predefined scalp area obtained at baseline, 1 month after the first PRP session, 1 month after the second PRP session, and 1 month after the third PRP session. Images were captured using a digital dermoscope at ×60 magnification, with quantitative analysis performed within a circular area of radius 2 mm. Serial trichoscopic images demonstrate temporal changes in follicular appearance following PRP treatment. All images were acquired under standardized magnification, lighting, and positioning conditions to ensure longitudinal comparability.

4.1 Results

Changes in Hair Density

Changes in hair density during the treatment period are presented in Table 2. Mean hair density increased from 169 ± 28 hairs/cm² at baseline to 185.67 ± 25.61 hairs/cm² after the second PRP session, representing a statistically significant improvement ($p = 0.005$). Hair density remained elevated after the third treatment session (182.89 ± 30.37 hairs/cm², $p = 0.002$), indicating a sustained treatment response.

Changes in Hair Subtype Distribution

Hair subtype counts are summarized in Tables 3–5. A transient increase in vellus hairs was observed during the early treatment phase, whereas intermediate and terminal hair counts showed no statistically significant changes. The vellus-to-terminal hair ratio demonstrated a gradual reduction during the treatment period (Table 6), suggesting a trend toward improvement in follicular characteristics.

Changes in Hair Shaft Diameter

Mean hair shaft diameter measurements are presented in Table **7**. A temporary reduction in mean hair diameter was observed during the early treatment phase, which may reflect the emergence of newly recruited thinner hairs prior to follicular maturation.

Safety and Patient-Reported Outcomes

PRP treatment was generally well tolerated. No serious adverse events were observed during the study period. Mild injection-site discomfort and transient scalp edema were occasionally reported immediately after treatment but resolved spontaneously without intervention. No cases of scalp infection occurred. Some participants reported subjective improvements in hair appearance and a perceived reduction in daily hair shedding during the treatment period. Overall patient satisfaction with treatment outcomes was generally positive, although formal satisfaction scales were not used in this pilot study.

Interpretation of Findings

The present study demonstrated a significant increase in hair density following PRP therapy in patients with mild androgenetic alopecia. Early treatment phases were characterized by a temporary increase in vellus hair counts and a reduction in mean hair shaft diameter, suggesting early follicular recruitment and activation.

However, several limitations should be considered. The small sample size and the predominance of female participants may limit the generalizability of these findings. Future studies with larger cohorts and a more balanced sex distribution are warranted to further evaluate the clinical efficacy of PRP therapy in androgenetic alopecia.

4.2 Discussion

The present study demonstrated that platelet-rich plasma (PRP) treatment was associated with short-term improvement in objective trichoscopic parameters in patients with mild androgenetic alopecia. The most consistent and statistically significant finding was an increase in total hair density during the treatment period, with measurable improvement observed after the second PRP session and sustained after the third session. These results suggest that PRP may induce early follicular activation and a measurable clinical response within a relatively short treatment period. This effect may be related to the biological activity of platelet-derived growth factors, including platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), and insulin-like growth factor-1 (IGF-1), which have been shown to stimulate dermal papilla cell activity and promote the transition of hair follicles into the anagen growth phase.

Despite the increase in hair density, changes in hair shaft morphology followed a different temporal pattern. Mean hair diameter showed a reduction during the early treatment phase, with partial recovery toward baseline values after the third PRP session. This suggests that early improvements in hair density were primarily driven by the emergence or recruitment of thinner hairs rather than immediate thickening of existing

terminal hairs. This interpretation is supported by the transient increase in vellus hair counts observed during the early treatment phase, while intermediate and terminal hair counts did not show statistically significant changes. Together, these findings indicate early follicular activation with transient recruitment of miniaturized or vellus hairs, whereas structural maturation and terminal hair conversion may require longer treatment duration or extended follow-up.

The magnitude of hair density improvement observed in this study was broadly consistent with previous clinical trials investigating PRP therapy for androgenetic alopecia. Randomized controlled studies have reported increases in hair density following serial PRP treatments, supporting the potential regenerative role of platelet-derived growth factors in promoting follicular activity and hair growth.

The apparent discrepancy between increased hair density and temporary reductions in hair diameter highlights the importance of evaluating multiple objective parameters when assessing treatment response in androgenetic alopecia. Improvements in hair density alone may overestimate early therapeutic success if not interpreted together with hair shaft diameter and follicular subtype distribution. In addition, mild androgenetic alopecia may demonstrate natural fluctuations in hair growth cycles, and placebo responses have been reported in hair restoration studies. Therefore, the observed changes should be interpreted cautiously in the absence of a control group.

Several limitations should be acknowledged. The small sample size, predominance of female participants, absence of a control group, and relatively short follow-up period limit the generalizability of the findings and preclude definitive conclusions regarding long-term treatment efficacy.

Future studies employing randomized controlled designs, larger cohorts, standardized PRP preparation protocols, and longer follow-up periods are warranted to further clarify the long-term impact of PRP therapy on follicular maturation, terminal hair conversion, and sustained clinical outcomes in patients with androgenetic alopecia.

5. Conclusion

This prospective pilot study suggests that three monthly sessions of platelet-rich plasma (PRP) therapy may improve hair density in patients with mild androgenetic alopecia, as measured by objective trichoscopic evaluation. The observed increase in hair density appeared to be primarily driven by early recruitment of thinner or vellus hairs, indicating early follicular activation rather than immediate terminal hair thickening. However, significant conversion to terminal hairs and sustained increases in hair shaft diameter were not clearly demonstrated within the short follow-up period.

Given the small sample size and absence of a control group, these findings should be interpreted with caution. Larger randomized controlled studies with longer follow-up are required to further evaluate the long-term clinical efficacy of PRP therapy and its potential role in promoting terminal hair maturation in androgenetic alopecia.

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