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Original Research Article

Clinical Efficacy of Platelet-Rich Plasma in the Management of Androgenetic Alopecia: A Prospective Comparative Study

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Abstract

Background: Androgenetic alopecia is a progressive, non-scarring hair-loss disorder that may be cosmetically improved with conventional topical therapy, which may be slow and incomplete. Objective: To assess the clinical efficacy and safety of platelet-rich plasma (PRP) as an adjunct to 5% topical minoxidil in patients with androgenetic alopecia. Objective: To compare the clinical efficacy and safety of platelet-rich plasma (PRP) when combined with 5% topical minoxidil in patients with androgenetic alopecia (AGA).

Methods: 80 clinically diagnosed androgenetic alopecia (AGA) adults were divided into two groups (A and B) with equal number of 40 each. Group A received monthly intradermal PRP treatment for 4 months along with 5% topical minoxidil and Group B received 5% topical minoxidil treatment for 6 months. Hair density, mean hair shaft diameter, hair-pull test, global photographic score, patient satisfaction and adverse events were measured at baseline, 3 months and 6 months.

Results: There were no differences in baseline characteristics between groups. At 6 months, Group A showed a significantly greater increase in hair density than Group B (37.2 +/- 15.6 vs 16.9 +/- 12.8 hairs/cm2; $p < 0.001$). Mean hair shaft diameter improved more in Group A (11.7 +/- 6.1 vs 6.1 +/- 5.3 microm; $p < 0.001$). The hair-pull test was negative in 82.5% of the PRP-treated patients and in 62.5% of the control patients ($p = 0.045$). The photographic improvements in Group A were moderate to marked in 75.0% and in Group B were 42.5% ($p = 0.003$). There were no serious adverse events reported, and the most frequent reported complaints related to PRP were transient pain and erythema.

Conclusions: PRP administered in addition to topical minoxidil resulted in better objective trichoscopic parameters and patient satisfaction than minoxidil alone, and was well tolerated in the short-term.

Keywords: androgenetic alopecia; platelet-rich plasma; hair density; minoxidil; trichoscopy; hair regrowth.

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Introduction

Androgenetic alopecia (AGA) is the most prevalent patterned hair loss disorder, where susceptible scalp follicles undergo progressive miniaturization, shorter anagen phase and transformation of terminal hair to vellus-like hair. The patterned distribution of male baldness was described classically by Hamilton [1] and the relative preservation of the frontal hairline in women with pattern hair loss was emphasized by later studies [2]. Despite being a benign condition, the chronic nature of AGA is often seen and causes anxiety, low self-esteem, lack of social confidence and a need for long-term treatment.

The underlying mechanism of AGA is a combination of genetic susceptibility, androgen signaling, dermal papilla activity, perifollicular microinflammation, and hair-cycle regulation. In many patients, signaling via dihydrotestosterone is key, but the expression of disease is variable and is not only dependent on levels of circulating androgens [3]. Current approved therapies, such as topical minoxidil and oral 5-alpha reductase inhibitors (5ARIs) in appropriate patients, are effective, but have limitations including slow onset of action, long-term use, low compliance, side effects with antiandrogens (sexual or systemic), and lack of cosmesis in more severe miniaturization.

Platelet-rich plasma (PRP) is an autologous biological concentrate derived from peripheral

blood and containing an increased platelet concentration, along with adhesive proteins, cytokines and growth factors. The principle behind PRP therapy is that the activated platelets release platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), transforming growth factor beta (TGF-β), epidermal growth factor (EGF), insulin-like growth factor (IGF), and other mediators that can affect tissue repair, angiogenesis, extracellular matrix remodeling, and cellular proliferation [4]. In hair restoration, platelet-derived mediators might play a role in the preservation of dermal papilla cells, perifollicular vascularity, and the activation of resting follicles into anagen.

The first clinical interest in platelet concentrates for hair restoration was in the context of surgical hair transplantation, where platelet plasma growth factors were correlated with increased follicular unit yield [5]. Subsequent non-surgical studies indicated that intradermal PRP injections may enhance the number, density and thickness of hair in certain AGA patients [6]. The biological plausibility of PRP was then confirmed by histomorphometric studies and controlled clinical trials, which showed increased epidermal thickness, perifollicular vascularity, follicular proliferation markers, and even computerized trichogram parameters following PRP therapy [7] [8].

Although it is being used more and more, the protocols used for PRP vary among studies. There is some variation in blood volume, centrifugation technique, platelet concentration, leukocytes, method of activation, depth of injection, number of sessions, maintenance interval, and concurrent use of minoxidil or finasteride. A randomized half-head study found that PRP was superior to saline, but the extent and longevity of benefit was different between patients [9]. Thus, further clinical comparative studies are required to determine the clinical utility of PRP as a complementary treatment to standard medical treatment. The aim of the present study was to evaluate the efficacy of PRP combined with topical minoxidil versus topical minoxidil alone in adults with AGA after 6 months, objective trichoscopic parameters, global clinical assessment, patient satisfaction and safety outcomes.

Materials and Methods

Study design: Prospective, parallel group comparative study was conducted in the outpatient dermatology and aesthetic medicine unit of tertiary care teaching hospital.

Population studied: Adults aged 18-50 years with clinically diagnosed androgenetic alopecia were screened. Eligible were male patients with Hamilton-Norwood grade II-V and female patients with Ludwig grade I-II. Patients were eligible if they had normal general health, were willing to attend follow-up visits and had not undergone any hair restoration surgery in the previous year. Exclusion criteria included scarring alopecia, alopecia areata, active scalp infection, uncontrolled thyroid disease, anemia, thrombocytopenia, platelet dysfunction, anticoagulant therapy, pregnancy or lactation, malignancy, tendency to keloids, and current systemic antiandrogen therapy or use of minoxidil, finasteride, dutasteride or PRP within the last 6 months.

Sample size and grouping: With an expected difference between groups of 15 hairs/cm2 in improvement in hair density, a standard deviation of 22 hairs/cm2, an 80% power, and a 5% alpha error, the minimum number of participants per group was determined to be 36. A total of 80 patients were recruited and randomly divided into two groups (Group A and Group B) with the same number by computer-generated sequence in sealed opaque envelopes to compensate for the possible attrition. Group A was given PRP injections with 5% topical minoxidil. Group B was given 5% topical minoxidil alone. Both groups received counseling on realistic expectations, compliance, avoiding severe hair treatments, and post-treatment needs.

PRP preparation and intervention: Under aseptic precautions, 18 mL of autologous venous blood was drawn into acid citrate dextrose tubes in Group A. The double spin method was performed: soft spin for 10 minutes at 1600 rpm and hard spin for 10 minutes at 3200 rpm. The platelet-rich layer was separated to collect around 3-4 mL of PRP. Every fifth sample had its platelet concentration checked and it was found to be 3.8 +/- 0.6 times the baseline platelet count. The scalp was first cleaned and then locally anaesthetized with the topical agent before PRP was injected intradermally into the affected areas of the frontal, mid-scalp or vertex with a 30-gauge needle at 1cm intervals using the nappage technique. Four sessions were conducted at one-month intervals. Both groups used 1 mL of topical minoxidil twice a day for 6 months.

Outcome assessment: A target area was fixed using anatomical landmarks and photographs of the scalp. Trichoscopic evaluation was conducted at baseline, 3 months and 6 months with standard magnification, lighting and hair trimming of the target area. The main outcome was the change in hair density (hairs/cm2) from baseline to 6 months. Secondary outcomes included mean hair shaft diameter (micrometers), hair-pull test positivity, physician global photographic assessment, patient satisfaction score (on a 10-point visual analogue scale), and adverse events. Two independent evaluators blinded to group allocation assessed the

global photographs from standardized frontal, temporal, vertex, and superior views.

Data analysis: The data were entered into Microsoft Excel and analyzed using SPSS version 26.0. All continuous variables were presented as mean ± SD and all categorical variables were presented as frequency and percentages. Independent-sample t-test or chi-square test were used to determine baseline comparability. Repeated measures analysis of variance (RM ANOVA) was used to analyse within-group changes, with Bonferroni correction. Independent-sample t-test was used for between-group comparisons at each time point and change-score comparisons. Chi-square or Fisher exact test were used to compare categorical outcomes. A p value of < 0.05 was deemed to be statistically significant.

Results

A total of 96 patients were screened, of whom 80 met the eligibility criteria and completed baseline assessment. Forty patients were included in each group, and all participants completed the 6-month follow-up. The study population included 47 males and 33 females with a mean age of 32.1 +/- 6.9 years. The mean duration of hair loss was 3.9 +/- 1.6 years. Baseline demographic characteristics, clinical grade distribution, family history, and trichoscopic parameters were comparable between the two groups. Hair density improved progressively in both groups, but the improvement was significantly greater in the PRP adjunct group. At 6 months, Group A showed a mean increase of 37.2 +/- 15.6 hairs/cm2 compared with 16.9 +/- 12.8 hairs/cm2 in Group B ($p < 0.001$). The mean hair shaft diameter also increased significantly in both groups, with greater gain in Group A. Hair-pull test positivity decreased from 87.5% to 17.5% in Group A and from 85.0% to 37.5% in Group B.

Global photographic assessment showed moderate or marked improvement in 30 patients (75.0%) in Group A compared with 17 patients (42.5%) in Group B. Mean patient satisfaction score at 6 months was significantly higher in Group A (8.1 +/- 1.2) than Group B (6.4 +/- 1.5; $p < 0.001$).

No serious adverse events were observed. Transient injection-site pain, mild edema, and short-lasting erythema were the most common PRP-related complaints and resolved without intervention. No patient discontinued treatment due to adverse effects.

Table 1: Baseline demographic and clinical characteristics

Variable	Group A: PRP + minoxidil (n=40)	Group B: minoxidil alone (n=40)	p value
Age, years	31.8 +/- 6.7	32.4 +/- 7.1	0.698
Male/female, n	24/16	23/17	0.819
Duration of hair loss, years	3.8 +/- 1.5	4.0 +/- 1.7	0.577
Family history present, n (%)	27 (67.5)	25 (62.5)	0.637
Male Hamilton-Norwood II-III, n (%)	15 (37.5)	14 (35.0)	0.816
Male Hamilton-Norwood IV-V, n (%)	9 (22.5)	9 (22.5)	1.000
Female Ludwig I-II, n (%)	16 (40.0)	17 (42.5)	0.820
Baseline hair density, hairs/cm2	102.6 +/- 18.4	104.3 +/- 17.9	0.678
Baseline hair shaft diameter, microm	52.1 +/- 7.8	50.9 +/- 8.2	0.504

Table 2: Trichoscopic and clinical outcome measures over follow-up

Outcome	Group	Baseline	3 months	6 months	Change at 6 months	p within group
Hair density, hairs/cm2	Group A	102.6 +/- 18.4	126.7 +/- 20.9	139.8 +/- 22.6	+37.2 +/- 15.6	<0.001
Hair density, hairs/cm2	Group B	104.3 +/- 17.9	115.9 +/- 19.1	121.2 +/- 20.1	+16.9 +/- 12.8	<0.001
Hair shaft diameter, microm	Group A	52.1 +/- 7.8	59.7 +/- 8.4	63.8 +/- 8.9	+11.7 +/- 6.1	<0.001
Hair shaft diameter, microm	Group B	50.9 +/- 8.2	54.8 +/- 8.6	57.0 +/- 8.7	+6.1 +/- 5.3	<0.001
Positive hair-pull test, n (%)	Group A	35 (87.5)	16 (40.0)	7 (17.5)	-28 patients	<0.001
Positive hair-pull test, n (%)	Group B	34 (85.0)	22 (55.0)	15 (37.5)	-19 patients	<0.001

Table 3: Global response, patient satisfaction, and adverse events at 6 months

Variable	Group A: PRP + minoxidil (n=40)	Group B: minoxidil alone (n=40)	p value
Mean patient satisfaction score (0-10)	8.1 +/- 1.2	6.4 +/- 1.5	<0.001
No or minimal photographic improvement, n (%)	10 (25.0)	23 (57.5)	0.003
Moderate improvement, n (%)	22 (55.0)	14 (35.0)	0.071
Marked improvement, n (%)	8 (20.0)	3 (7.5)	0.105
Transient injection-site pain, n (%)	34 (85.0)	0 (0.0)	<0.001
Mild erythema or edema, n (%)	12 (30.0)	3 (7.5)	0.010
Transient scalp itching, n (%)	4 (10.0)	5 (12.5)	0.723
Serious adverse event, n (%)	0 (0.0)	0 (0.0)	NA

Discussion

The present prospective comparative study revealed that PRP treatment in combination with 5% topical minoxidil resulted in significantly greater improvement in hair density, hair shaft diameter, hair-pull test conversion, photographic response and patient satisfaction compared to topical minoxidil alone. The improvement was clinically meaningful, as the difference between the groups was statistically significant in the trichoscopic scores and also in blinded photographic grading and patient satisfaction. These results suggest that PRP is a useful adjunct to the regeneration process in carefully selected patients with early to moderate AGA.

The findings are similar to those obtained in the randomized setting in female pattern hair loss where activated PRP showed significantly better hair density and clinical response compared to placebo [10]. Likewise, a randomized placebo-controlled pilot study in male AGA showed improvement following multiple PRP treatments, but with variable results, highlighting the importance of standardized treatment schedules [11]. The present protocol involved four monthly sessions which might account for the progressive gain between 3 and 6 months. This schedule is feasible in outpatient environments due to its balance of biological stimulation, patient convenience, and cost.

One of the unresolved issues of PRP therapy is product heterogeneity. Siah et al. demonstrated that the level of growth factors in PRP samples can differ significantly and can affect biological activity [12]. In an effort to minimize this variation, we employed a standard double-spin protocol and periodic platelet-count monitoring. But platelet count is not the only factor that determines PRP. Clinical response may be influenced by the concentration, activation status, architecture of fibrin, and release kinetics of growth factors by leukocytes. Future studies should report more detail of PRP composition to enable meaningful comparisons between trials.

Randomized controlled studies have yielded mixed, but mostly positive, results. In a split-scalp design, Shapiro et al. found that PRP enhanced hair regrowth parameters and hair thickness, but noted that the ideal dose and patient selection were not yet known [13]. Dubin et al. specifically examined female AGA and observed that PRP was beneficial in women as well as in male pattern hair loss [14]. The present study was conducted in both men and women patients and similar direction of benefit was observed but not powered for sex-specific subgroup analysis.

Systematic reviews and meta-analyses have been increasingly supporting PRP for AGA, but also have recognized the poor quality of studies and protocol diversity. Evans et al. found PRP to be correlated with increased hair density; however, they noted that there was heterogeneity and small sample sizes among the trials that included PRP [15]. Another recent meta-analysis of randomized trials also revealed that PRP was effective for increasing hair density, with inconsistent data for hair count and hair diameter [16]. The results of the present study are consistent with these analyses, as there was a higher density response than diameter response, but both responses were significantly improved.

The clinical potential of PRP might be most useful when it is combined with standard medical care, not used alone. Most controlled studies reported increases in density or count, with methodological quality varying, as reported by Donnelly et al. [17]. The present study used a combined-therapy model, and Yao et al. specifically investigated PRP combined with topical minoxidil, which also revealed additive benefit in 2024 [18]. The mechanism of action of Minoxidil and PRP may be complementary because Minoxidil can extend anagen and improve the caliber of the follicles, and PRP can stimulate growth factors in an autologous manner.

Safety profile in this study was acceptable. Minimal pain, erythema and mild edema were anticipated after intradermal injection and were self-limiting. There was no infection, scarring, vasovagal event or persistent worsening noted. Patient counselling is still necessary as PRP is procedure-dependent, needs multiple treatments

and does not give instant cosmetic thickening. Those with advanced miniaturization of the hair follicles, long-standing bald areas, uncontrolled systemic disease, or unrealistic expectations may not fare well.

There are some limitations in this study. The follow-up period was short (6 months) and thus durability and maintenance requirements were not evaluated. Allocation was prospective but the intervention was not blinded for patients because of the injections. The sample size was sufficient to detect changes in hair density, but not to provide strong subgroup analyses by sex, AGA grade, and baseline platelet count or disease duration. Biochemical quantification of individual growth factors was not carried out. More comprehensive and standardized multi-center trials with more extended follow-up periods, maintenance protocols, and quality of life instruments are required before universal treatment algorithms can be created.

Conclusion

In this prospective comparative study, PRP as an adjunct to 5% topical minoxidil was more effective than topical minoxidil alone in treating patients with androgenetic alopecia within the limits of this study. PRP resulted in higher improvement rates in hair density, hair shaft diameter, hair-pull test conversion, photographic response, and patient satisfaction, with no serious adverse events.

The results indicate that PRP is a useful, minimally invasive, self-derived treatment modality for early to moderate AGA when applied with an optimized medical treatment. Long-term controlled studies are needed to establish optimal ways to prepare, session frequency, maintenance intervals, and predictors of sustained response.

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