


# Platelet Rich Plasma and Its Use in Hair Regrowth: A Review

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**Abstract:** Platelet rich plasma (PRP) was described as a small volume of plasma containing higher concentrations of platelets than those found in peripheral blood and initially used as a transfusion product for treatment of thrombocytopenia. To date, it was discovered that there are several growth factors and cytokines that can accelerate wound healing and tissue regeneration, leading to a wider range of applications in the medical field, such as in sport medicine, regenerative medicine, and aesthetic medicine. Several studies have shown that PRP can be used effectively for treatment of hair loss. Although it has been widely used, the exact mechanism of action of PRP is still not fully elucidated. In this article, we aim to review and update current information on the definition, classification, mechanism of action, clinical efficacy in hair regrowth, and adverse events of PRP.

**Keywords:** platelet rich plasma, androgenetic alopecia, female pattern hair loss, alopecia areata, cicatricial alopecia, hair transplantation

## Introduction

Platelet rich plasma (PRP) was first described in Hematology as a small volume of plasma containing higher concentrations of platelets than those found in peripheral blood and initially used as a transfusion product for treatment of thrombocytopenia since 1970.<sup>1</sup> Nowadays, PRP has become a popular treatment for many conditions in sport medicine,<sup>2</sup> regenerative medicine,<sup>2,3</sup> aesthetic medicine<sup>4</sup> and hair loss treatment<sup>5,6</sup> as it contains a variety number of growth factors and cytokines that can accelerate wound healing and tissue restoration. Both the device used to separate platelets and the subsequent use of the PRP product fall under the regulation of the US Food and Drug Administration (FDA).<sup>7</sup> Any use of PRP other than blood transfusion is an “off label use” which is not prohibited by the FDA regulation if performed by a physician with the intent to practice medicine. Despite its widely application, the mechanism underlying the hair regrowth effects of PRP remains to be fully explored. We aim to review the effectiveness of PRP as a treatment for hair loss including definition, classification, mechanism of action, clinical efficacy in hair regrowth, and adverse effects.

## Definition

Platelet-rich plasma, also known as platelet-rich growth factors or platelet concentrate, is a concentrate of platelet-rich plasma protein derived from whole blood, centrifuged to remove red blood cells. In addition to the main component that contains high concentrations of platelets, there are also other components, such as, the presence or absence of leucocytes and platelet-activating agents, which used to define different types of PRP. The effectiveness of stimulating tissue regeneration depends on the concentration of platelets present in the plasma, several studies have shown that concentrations two to six times higher than normal platelet count is required for optimal outcomes.<sup>8</sup>

## Preparation

Due to the lack of a standardized method of preparation and application of PRP, there is a wide variety method of preparation. However, the main principle is to prepare concentrated platelets from the patient's own blood. All PRP preparation protocols follow a generic method, started with collecting venous blood approximately 10 to 60 mL from the patient and placing it into tubes containing an Anticoagulant, either acid citrate dextrose or sodium citrate solution to prevent coagulation and premature secretion of the alpha granules. Subsequently, whole blood is centrifuged and divided into 3 layers based on specific gravity, the bottom layer contains red blood cells (RBCs) with leukocytes the middle layer is the PRP, and the top layer is platelet-poor plasma (PPP).<sup>9</sup> There are several types of commercial PRP kits that simplify the PRP preparation. These kits differed in platelet concentrations, the presence of leukocytes and platelet activator leading to the diversity of growth factors concentration. All of these explain the variability in the clinical benefits of PRP reported in the literature. Some studies induced growth factor secretion and degradation of alpha granules by adding calcium gluconate, calcium chloride, or thrombin before administration (activated PRP). There is no consensus as to whether platelets must be activated exogenously or use host thrombin as endogenous activator in order to maximize the therapeutic effect.<sup>10–12</sup> The platelet alpha granules secrete growth factors within 10 minutes after clotting or activation, so PRP should be used within 10 minutes of activation for maximum benefits.<sup>13</sup>

## Classification of Platelet Rich Plasma

There are many variations in PRP preparations, from the type of collection tubes, power used, the number of cycles and the duration of centrifugation, components of PRP and an activation method was applied. A standardized classification of PRP called DEPA was proposed by Magalon et al, based on four components: dose of injected platelets (baseline concentration of platelets at  $200 \times 10^9/L$ ), efficiency of the process (platelet recovery rate %), purity of PRP (relative composition in platelets %) and activation process,<sup>14</sup> as shown in Table 1. From this classification, an “AAA” DEPA score is referred to a high-concentration platelet injection (>5 billion) with minimal red blood cell contamination and well prepared with a proper method resulting in minor loss of platelets from whole blood. The last category in the DEPA classification is reporting the presence or absence of any exogenous activator, such as thrombin or calcium chloride.

## Mechanism of Action

Currently, many studies have demonstrated that platelets not only affect hemostatic system, but also affect inflammatory system, angiogenesis, stem cell induction, and cell proliferation through the release of many different growth factors and cytokines.<sup>15–17</sup> Activated platelets in PRP release numerous growth factors and cytokines from their alpha granules, including platelet-derived endothelial growth factor (PDGF), transforming growth factor  $\beta$  (TGF- $\beta$ ), fibroblast growth factor-2 (FGF-2), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), insulin-like growth factor-1 (IGF-1), glial cell line-derived neurotrophic factor (GDNF), which play a major role in stimulating hair growth through cell proliferation, differentiation and angiogenesis.<sup>18–22</sup> GDNF can stimulate cell proliferation and protect hair follicle

**Table 1** DEPA Score is Categorized in Order from A to D

Dose of Injected Platelets (Billions)	Efficiency of the Process (Platelet Recovery Rate %)	Purity of the PRP (Relative Composition in Platelets %)
A >5 very high dose	A >90 high	A >90 very pure PRP
B 3–5 high dose	B 70–90 medium	B 70–90 pure PRP
C 1–3 medium dose	C 30–70 low	C 30–70 heterogeneous PRP
D <1 low dose	D <30 poor	D <30 whole blood PRP

**Notes:** Adapted from: Magalon J, Chateau AL, Bertrand B, et al. DEPA classification: a proposal for standardising PRP use and a retrospective application of available devices. *BMJ Open Sport Exerc Med*. 2016;4(2(1)):e000060. doi:10.1136/bmjsem-2015-000060.<sup>14</sup> Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license (<http://creativecommons.org/licenses/by-nc/4.0/>).

**Abbreviations:** DEPA, dose of injected platelets, efficiency of production, purity of the PRP, activation of the platelet-rich plasma.

from premature catagen transition.<sup>23,24</sup> VEGF play a major role as a potent hair growth stimulator via an angiogenesis induction.<sup>25,26</sup> While IGF-1 stimulates proliferation of cycling Ki67<sup>+</sup> basal keratinocytes, induce and prolong the anagen phase of the hair growth cycle.<sup>27–29</sup> In addition, PRP can induce the proliferation of dermal papilla (DP) cells by activating extracellular signal-related kinase (ERK), fibroblast growth factor 7 (FGF-7), beta-catenin, and Akt signaling (an anti-apoptotic signaling molecule). There is also an increase in expression of Bcl-2 protein (an anti-apoptotic protein) in vitro human dermal papilla cells cultured with PRP. Thus, it was clearly illustrated that PRP can increase the survival of hair follicle cells through anti-apoptotic effects and stimulate hair growth by extending the anagen phase of the hair cycle.<sup>30</sup> This theory was further supported by the results of microscopic examination which demonstrated an increase in number of follicular bulge cells, hair follicles, epidermal thickening, vascularization, and a higher number of Ki67<sup>+</sup> basal keratinocytes in PRP-treated scalp tissue compared with placebo.<sup>31</sup>

## Contraindication

Although PRP is a safe treatment with minimal side effects, there are some contraindications that need to be considered. Absolute contraindication for PRP include critical thrombocytopenia, platelet dysfunction, hemodynamic instability, sepsis, local infection (site PRP) and patient with unwilling to accept risk. Relative contraindications include NSAIDs use in 48 hours, glucocorticoid injection at treatment site within one-month, systemic glucocorticoid within 2 weeks, recent illness or fever, cancer especially bone or hematolymphoid, anemia (hemoglobin less than 10 grams per deciliter), thrombocytopenia (platelets less than 150,000 per microliter) and tobacco use.<sup>32</sup>

## Use of Platelet Rich Plasma in Hair Disorders

### Androgenetic Alopecia

Androgenetic alopecia (AGA) is a non-scarring alopecia characterized by a shortened anagen phase and progressive miniaturization of terminal hairs into vellus hairs.<sup>33</sup> This condition is found in approximately 50% of Caucasian men by the age of 50 years, and in women, it can be as much as 50% over the course of their lifetime.<sup>34</sup> In men, baldness started with frontal recession and thinning of hair on vertex area (MPHL), while in women, hair loss is characterized by less hair density and smaller hair shaft diameter over the crown without frontal hairline recessions (FPHL). FDA has approved oral finasteride (for men only) and topical minoxidil for the treatment of AGA.<sup>35</sup>

A meta-analysis from six studies (four studies were randomized controlled trials, while the other two were retrospective studies) involving 177 patients, showed a significant increase in number of hairs per cm<sup>2</sup> after PRP injections compared to control (mean difference (MD) 17.90, 95% CI 5.84–29.95, P=0.004) and the tendency to increase in number of hairs and the percentage of hair thickness.<sup>36</sup> Similar result was confirmed by another two meta-analysis studies which showed a significantly increased hair numbers per cm<sup>2</sup> after PRP injections in the treatment group versus the control group with MD 38.75, 95% CI 22.22–55.28, P <0.00001 and MD 30.35, 95% CI 1.77–58.93, P <0.00001, respectively.<sup>37,38</sup> Compared to minoxidil, finasteride, and adult stem cell-based therapy, 84% of all studies reported a positive effect of PRP, 50% demonstrated a statistically significant improvement while 34% showed hair density and hair thickness improvement, although no P values or statistical analysis was described.<sup>39</sup>

Despite several clinical trials showed the success of PRP therapy in AGA, there is no standard practice for PRP preparation and administration as well as a method to evaluate results. Attempts have been made to standardize PRP treatment for AGA patients. A standard PRP procedure was proposed by Stevens et al, employing a single spin centrifugation method to produce pure PRP with a platelet enrichment of 3 to 6 times the mean concentration of whole blood and adding a platelet activator such as calcium chloride or calcium gluconate before administration of PRP as subdermal injections. Treatment intervals should include monthly sessions for the first 3 months, then every 3 months for the first year.<sup>27</sup>

However, there is still debate in the literature about the standardization of PRP preparation. A split scalp prospective comparative clinical study included 15 females with AGA was performed by intradermal injection of double-spin prepared PRP into the right half of the scalp and single-spin prepared PRP into the left half of the scalp of each patient for three treatment sessions, 3 weeks apart. Results showed clinical improvement in both sides of scalp while hair density

measured by trichoscan revealed that the right half of the scalp was significantly higher in median terminal hair density than the left half ( $P=0.031$ ), which illustrated that double-spin method could yield better results than single-spin method.<sup>40</sup> In addition, there was a comparative study demonstrated that patients treated with non-activated PRP were found to have greater increase in hair count and total hair density ( $31\% \pm 2\%$  versus  $19\% \pm 3\%$ ,  $P=0.0029$ ) than patients treated with activated-PRP, leading to the conclusion that PRP does not require activation before injection.<sup>31</sup>

The important factors that affect the effectiveness of PRP is the number of platelets. Higher numbers of platelets have a greater effect than lower numbers of platelets in terms of hair density, follicle diameter, and terminal hair density.<sup>41</sup> In AGA, action of dihydrotestosterone on dermal papilla cells suppressed canonical WNT signaling, resulting in defective hair growth and retarding hair cycling. PRP promoting hair growth by activating WNT/ $\beta$ -Catenin signaling lead to proliferation and differentiation of hair follicle cells and triggering new hair cycle.<sup>42</sup>

Some studies have reported ineffectiveness of PRP in AGA treatment, which may be caused by low platelet concentration, low volume of PRP injected, and inadequate frequency of treatment.<sup>9</sup> The treatment response to PRP in AGA patients can be predicted by measuring pro-inflammatory cytokine IL-1 $\alpha$  polymorphism from peripheral blood. A study has reported significantly higher frequency of C/C genotype of IL-1 $\alpha$  in responder (66%) than in non-responder patients (22%) with odds ratio (OR) 6.68, 95% CI 0.99–72.95 ( $p<0.05$ ).<sup>43</sup>

Evidence from randomized controlled trials of PRP in AGA is summarized in Table 2.

## Female Pattern Hair Loss

Female pattern hair loss (FPHL) is the most common cause of hair loss in middle-aged women, characterized by progressive follicular miniaturization and conversion of terminal follicles into vellus-like follicles, leading to a decrease in hair density, thinning of hair and diffuse non scarring alopecia especially in the central, frontal and parietal regions of the scalp. The cause of this problem is unknown, but it is related to genetics, hormones, and environmental conditions.<sup>49</sup>

A systemic review study evaluating the efficacy of PRP in the treatment of FPHL comprising 92 patients from 6 randomized controlled clinical trials showed that PRP has a positive effect on FPHL treatment by increasing hair thickness and hair density.<sup>50</sup> Recently, two meta-analysis studies have confirmed the efficacy of FPHL treatment with PRP. The first study consisted of 776 female participants covering 16 randomized controlled trials and 26 observational trials, demonstrated that PRP has a good therapeutic effect on FPHL in hair density compared to the control groups with OR 1.61, 95% CI 0.52–2.70, and compared to baseline with OR 1.11, 95% CI 0.86–1.37.<sup>51</sup> The second study from 8 clinical studies and a total of 197 subjects showed a significant increase in hair count and hair diameter in 4 studies after PRP treatment. Moreover, PRP has been shown to produce high levels of satisfaction and improvement in the quality of life in patients affected by FPHL.<sup>52</sup>

Differences in the treatment efficacy for AGA with PRP between men and women was discovered by a meta-analysis study, which revealed that PRP significantly increased both hair density ( $N=250$ , MD = 25.83, 95% CI: 15.48–36.17,  $P<0.00001$ ) and hair diameter ( $N=123$ , MD = 6.66, 95% CI: 2.37–10.95,  $P=0.002$ ) in men while significantly increased hair diameter ( $N=95$ , MD = 31.22, 95% CI: 7.52–54.91,  $P=0.01$ ), but did not increase hair density ( $N=92$ , MD = 43.54, 95% CI: –1.35–88.43,  $P=0.06$ ) in women.<sup>53</sup> However, PRP effectiveness in the treatment of AGA is influenced by gender is still controversial because of the differences in several reports listed, many of the analyzed studies were non-randomized, uncontrolled, and had small sample size.

Evidence from randomized controlled trials of PRP in FPHL is summarized in Table 3.

## Alopecia Areata

Alopecia areata (AA) is a common autoimmune disorder that causes nonscarring alopecia in males and females at any age. The estimated lifetime risk of AA is around 2% of population, with no difference in incidence between genders. Most patients have only one lesion of alopecia and spontaneous hair regrowth can occur within months to years. However, there are many patients who may develop multiple lesions and turn into chronic hair loss.<sup>58</sup>

PRP was discovered to have a potent anti-inflammatory effect. It suppresses cytokine release and decreases local tissue inflammation, which makes PRP potentially beneficial in treating inflammatory hair loss such as AA.<sup>59,60</sup> PRP was initially tested in patients with AA by a randomized, double-blind, placebo controlled, half-head study. Forty-five

**Table 2** Randomized Controlled Trials of PRP in Male Androgenic Alopecia

Author, Year	Number of Patients	Platelet Rich Plasma Preparation	Treatment Regimen	Results
Qu Q et al 2021 <sup>42</sup>	N= 52 (32M 20F)	- Double spin - without PLT activator - PLT count: NR	3 injections (monthly) with PRP VS saline  (half-head study)	6 months: significant increase in hair density, hair thickness and anagen hair ratio in PRP compared to placebo
Pakhomova EE et al 2020 <sup>44</sup>	N= 69 M	- Double spin - with PLT activator - PLT count: $882.5 \pm 143.62 \times 10^9/L$	1. Topical minoxidil 5% (23) 2. 4 injections (monthly) with PRP (23) 3. 4 injections (monthly) with PRP + topical minoxidil 5% (23)	4 months: significant increase in hair density and hair thickness in PRP + topical minoxidil group followed by PRP monotherapy group
Shapiro et al 2020 <sup>45</sup>	N= 35 (18M17F)	- Single spin - without PLT activator - PLT count: NR	3 injections (monthly) with PRP VS saline (two 7.6-cm × 7.6-cm squares, split head study)	3 months: significant increase in hair density and hair thickness in PRP compared to baseline, but not significant increase compared to placebo
Dicle et al 2020 <sup>46</sup>	N= 30 M	- Single spin - with PLT activator - PLT count: NR	3 injections (monthly) with PRP first (10) VS saline first (15) (first half of crossover trial)	4 months: significant increase in hair density in the group that received placebo and subsequently received PRP injections (after wash- out period)
Singh et al 2020 <sup>47</sup>	N= 80 M	- Double spin - with PLT activator - PLT count: 4.2-fold higher than whole blood	1. Topical minoxidil 5% + 3 injections (monthly) with saline (20) 2. Topical minoxidil 5% + 3 injections (monthly) with PRP (20) 3. Topical placebo + 3 injections (monthly) with saline (20) 4. Topical placebo + 3 injections (monthly) with PRP (20)	5 months: significant increase in hair density in PRP + topical minoxidil group followed by PRP + topical placebo group
Rodrigues et al 2019 <sup>48</sup>	N= 26 M	- Double spin - with PLT activator - PLT count: $1200 \times 10^6 /\mu L$	4 injections (every 15 days) with PRP (15) VS saline (11)	3 months: significant increase in hair density and percentage of anagen hairs in PRP group compared to placebo group
Gentile et al 2017 <sup>31</sup>	N= 18 M	- Single spin - without PLT activator - PLT count: 5 fold higher than whole blood	3 injections (monthly) with PRP VS saline  (half-head study)	3 months: significant increase in hair density in PRP compared to placebo

**Abbreviations:** PLT, platelet; NR, not reported.

patients with AA were randomized to receive intralesional injections of PRP or triamcinolone acetonide or placebo on one half of their scalp, while the other half was untreated. The results showed that PRP significantly increased hair regrowth and Ki-67 level (marker for cell proliferation) compared with triamcinolone acetonide or placebo injection.<sup>61</sup> Collectively, many randomized controlled trials demonstrated that treatment with PRP can stimulate hair regrowth to the same extent as intralesional injection of triamcinolone acetonide in the treatment of AA.<sup>62–65</sup> Two recent studies

**Table 3** Randomized Controlled Trials of PRP in Female Pattern Hair Loss

Author, Year	Number of Patients	Platelet Rich Plasma Preparation	Treatment Regimen	Results
Dubin DP et al 2020 <sup>54</sup>	N= 30F	- Single spin - without PLT activator - PLT count: NR	3 injections (monthly) with PRP (14) VS saline (14; 2- loss follow up)	6 months: significant increase in hair density and hair thickness in PRP group compared to placebo group
Bruce et al 2019 <sup>55</sup>	N= 20F	- Double spin - with PLT activator - PLT count: NR	3 injections (monthly) with PRP first (9) VS minoxidil foam first (9) (first half of crossover trial)	4 months: significant increase in vellus hair density and hair count in both groups compared to baseline
Tawfik and Osman, 2018 <sup>56</sup>	N= 30F	- Double spin - with PLT activator - PLT count: NR	4 injections (weekly) with PRP VS saline (half-head study)	6 months: significant increase in hair density and hair thickness in PRP compared to placebo
Lee et al 2015 <sup>57</sup>	N= 40F	- Single spin - with PLT activator - PLT count: 1,256,950 ± 371,397 cells/ $\mu$ L	Single PRP with 12 sessions of PDRN injections (20) VS 12 sessions of PDRN injections only (20)	3.25 months: combined therapy with PRP induced more hair thickness than PDRN alone

**Abbreviations:** PLT, platelet; NR, not reported; PDRN, polydeoxyribonucleotide.

compared the therapeutic effect of intralesional injections of PRP with triamcinolone acetonide in AA. One study found that final severity of alopecia tool (SALT) score showed significant lower levels in both groups compared to baseline levels ( $P = 0.025$  and  $P = 0.008$ ) with no significant difference between both treatment modalities in term of clinical improvement, while final alopecia areata symptom impact scale (AASIS) showed significant decrease in PRP group ( $P = 0.006$ ) but not in triamcinolone group ( $P = 0.062$ ).<sup>62</sup> Similar results were found in the other study by showing that there was no statistically significant difference in SALT score reduction and hair regrowth scale between these two groups.<sup>63</sup>

On the contrary, different results were found in three randomized controlled clinical trials which demonstrated that PRP was significantly less effective than intralesional steroid injection based on Mac Donald Hull and Norris grading system, percentage of hair regrowth and reduction in SALT score from baseline, respectively.<sup>66–68</sup> All these results could explain that steroid is more potent than PRP in terms of having immunosuppressive and strong inhibitory effect on T lymphocyte activation.

A beneficial effect of combination therapy with PRP was reported in a patient with long standing AA treated with a combination of intralesional injection of triamcinolone acetonide and PRP in one half of the scalp while the other half of the scalp was treated with intralesional triamcinolone acetonide only. The half head treated with the combined therapy showed greater hair regrowth and larger hair fiber diameter.<sup>69</sup> Furthermore, there was a prospective study on the efficacy of PRP treatment in 20 cases of chronic AA who had not responded to conventional therapy for 2 years, demonstrated that all patients with chronic AA were successfully treated with PRP, only one patient had a relapse after one year of follow-up.<sup>70</sup> The successful treatment with PRP was also reported in a patient with corticosteroid-resistant ophiasis AA who experienced hair regrowth after PRP injections<sup>71</sup> and a patient who suffering from alopecia areata barbae.<sup>72</sup> Hence, PRP can be used as an alternative therapy in patients unresponsive to conventional therapy or patients who do not want to be treated with steroids and can also be used as an adjuvant therapy for alopecia areata.

Evidence from randomized controlled trials of PRP in AA is summarized in Table 4.

## Cicatricial Alopecia

Cicatricial alopecia is a type of scarring alopecia, caused by different inflammatory conditions, physical trauma, burn, or severe infections that lead to the destruction of the hair follicles and subsequent scarring. The goal of treatment is to stop



**Table 4** Randomized Controlled Trials of PRP in Alopecia Areata

Author, Year	Number of Patients	Platelet Rich Plasma Preparation	Treatment Regimen	Results
Fawzy MM et al 2021 <sup>62</sup>	N= 31 (23M8F)	- Single spin - without PLT activator - PLT count: 750,000–1,000,000/ $\mu$ L	3 injections (monthly) with 1.PRP (17) 2.Triamcinolone acetonide 40 mg/mL (14)	4 months: significant reduction in SALT score in both groups compared to baseline
Balakrishnan A et al 2020 <sup>63</sup>	N= 40 (22M18F)	- Double spin - without PLT activator - PLT count: NR	3 injections (monthly) with 1.PRP (16) 2.Triamcinolone acetonide 10 mg/mL (16)	3 months: significant improvement in clinical symptoms in both groups, but there was no significant difference between these two groups
Hegde P et al 2020 <sup>64</sup>	N= 50	- Double spin - without PLT activator - PLT count: NR	3 injections (monthly) Right side of the scalp with 1.PRP (25) 2.Triamcinolone acetonide 10 mg/mL (25) Left side of the scalp with saline	5 months: SALT score showed statistically significant improvement from baseline in both groups. Steroid group showed the most hair regrowth, followed by PRP group
Kapoor P et al 2020 <sup>68</sup>	N= 40	- Single spin - without PLT activator - PLT count: 3.5-fold higher than whole blood	4 injections (every 3 weeks) with 1.PRP (20) 2.Triamcinolone acetonide 10 mg/mL (20)	6 months: significant reduction in SALT score in triamcinolone group compared to PRP group
Albalat et al 2019 <sup>65</sup>	N= 80 (68M12F)	- Double spin - with PLT activator - PLT count: NR	3-5 injections (every 2 weeks) with 1.PRP (40) 2.Triamcinolone acetonide 5 mg/mL (40)	6 months: significant increase in hair regrowth and reduction of dystrophic hair in both groups, but there was no significant difference between these two groups
Agrawal P et al 2018 <sup>67</sup>	N= 30	- Double spin - with PLT activator - PLT count: NR	3 injections (monthly) with 1.PRP (15) 2.Triamcinolone acetonide 5 mg/mL (15)	6 months: significant increase in the percentage of hair regrowth in triamcinolone group compared to PRP group

**Abbreviations:** PLT, platelet; NR, not reported; SALT, severity of alopecia tool score.

the disease progression, prevent further hair loss and scarring by using different anti-inflammatory drugs, such as topical steroid, intralesional triamcinolone acetonide injection and immunomodulating agents. However, there is no effective treatment to stimulate hair regrowth in fibrotic area.<sup>73</sup>

Frontal fibrosing alopecia (FFA), a variant of lichen planopilaris, is currently the most common type of cicatricial alopecia characterized by progressive recession of the frontal and temporoparietal hairline along with perifollicular erythema and papules leading to band-shaped scarring alopecia in the frontotemporal area.<sup>74</sup> The satisfactory treatment outcome with five consecutive PRP injections was reported in a 44-year-old female with FFA, who had a history of unresponsive to conventional intralesional steroid therapy. Only one month after treatment, perifollicular erythema, scaling, and lichenoid papules on the frontotemporal hairline were improved, and no further hair loss was seen after 5 months.<sup>75</sup>

Lichen planopilaris (LPP) is a chronic inflammatory scarring alopecia characterized by follicular hyperkeratosis, perifollicular erythema, and loss of follicular orifices on vertex and parietal area of the scalp. Bolanča et al have reported for the first time the efficacy of PRP therapy in a case of LPP diagnosed by histopathology and unresponsive to any previous treatments. After 3 consecutive treatments of PRP and followed up for 6 months, patients experienced complete regression of scalp itching and hair shedding, confirmed by undetectable perifollicular erythema and scaling on trichoscopic examination.<sup>76</sup> Subsequently, two patients with central centrifugal cicatricial alopecia (CCCA) and one

patient with LPP were reported on the success of PRP treatment, resulting in a significant increase in hair density despite a history of unresponsiveness to conventional therapy before.<sup>77,78</sup>

Effective treatment of cicatricial alopecia with PRP is possible due to various cytokines and growth factors such as TGF $\beta$ , TGF $\beta$ 1 in platelet granules, which have anti-inflammatory and proangiogenic effects.<sup>79</sup> Although there is evidence that PRP can be used as an effective treatment for some types of cicatricial alopecia, more clinical trials are needed to produce further evidence.

## Hair Transplantation

Several studies have shown a beneficial effect of using PRP in combination with hair transplantation. The first report was an experimental study in a group of 20 patients with male pattern baldness demonstrated a 15% greater hair yield in follicular unit density in areas pretreated the harvested donor with platelet plasma growth factors obtained from the patient's autologous plasma as compared with normal saline (18.7 follicular units per cm<sup>2</sup> vs 16.4 follicular units per cm<sup>2</sup>).<sup>22</sup> Similar results were found in another two studies, the first was a comparative study showed that transplanted follicular unit grafts in conjunction with platelet lysate (PL) or activated PRP (AA-PRP) resume growth faster than normal saline at 4 months after operation, 99%, 75%, and 71% of follicle regeneration had occurred in the PL, AA-PRP, and saline treatment areas, respectively.<sup>80</sup> The second was a randomized controlled study demonstrated that preserving hair grafts in PRP before implantation enhances the hair density, the graft uptake, and the hair thickness compared with preserving in normal saline.<sup>81</sup>

Furthermore, PRP can also be used as a combination treatment with the follicular unit extraction (FUE) hair transplantation as shown in a single-blind, prospective randomized study in 40 FUE hair transplant patients. The patients were divided into two groups, PRP was injected intra-operatively immediately after creating slits over the recipient area in PRP group while normal saline was injected in non-PRP group. It was clearly seen that intra-operative PRP therapy is profitable in giving significantly improved density and quality of hair growth, reducing the catagen loss of transplanted hair, early recovery of the skin and faster appearance of new anagen hair in FUE transplant patients.<sup>82</sup> Thus, PRP is not only an effective hair loss treatment, but it can also be used as an adjunct to hair transplantation.

## Adverse Effects of Platelet Rich Plasma

PRP is an autologous preparation of plasma with a high concentration of platelets. It is relatively safe intervention with minimal adverse effects, including temporary and tolerable pain during treatment, mild headache, minimal itching, transient erythema and edema on treated area. No major side effects such as scarring, infections, panniculitis, hematoma or allergic reaction have been documented following PRP treatment.<sup>39,83,84</sup> After treatment, patients can resume normal daily activities, no antibiotics are needed to prevent infection. Most patients can return to work the following day.

## Conclusion

PRP can be used as a new therapeutic option for hair loss including androgenetic alopecia and female pattern hair loss, either as a monotherapy or an adjuvant to conventional therapy or hair transplantation. PRP is also considered a safe, effective, steroid sparing, and alternative treatment for alopecia areata. Moreover, there was evidence showing that PRP can improve clinical symptoms in some types of cicatricial alopecia. However, further studies are needed to determine the standard of PRP treatment preparation, treatment regimen, including dosing protocols, injection technique, number and interval of optimal treatment sessions in order to achieve the maximum therapeutic efficiency.

## Data Sharing Statement

The reader can personally request to access the data via Dr. Anon Paichitrojjana; E-mail: anonpaic@gmail.com.

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