PLATELET-RICH PLASMA AND ADIPOSE-DERIVED MESENCHYMAL STEM CELL THERAPY IN CICATRICIAL ALOPECIA - MECHANISMS OF FOLLICULAR RESCUE AND REGENERATIVE EFFICACY

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Annotation: *This study investigates the regenerative potential of platelet-rich plasma and adipose-derived mesenchymal stem cell therapies in early-stage primary cicatricial alopecia, evaluating their capacity to modulate perifollicular fibrosis, restore follicular stem cell niche integrity, and promote partial follicular rescue. Through phototrichogram analysis, growth factor quantification, and serial histomorphometric scalp biopsy assessment, the research delineates the mechanistic and clinical efficacy of regenerative interventions in halting irreversible follicular unit loss.*

Keywords: *platelet-rich plasma, adipose-derived mesenchymal stem cells, follicular stem cell niche, perifollicular fibrosis, transforming growth factor beta, vascular endothelial growth factor, platelet-derived growth factor, trichogram, regenerative dermatology, cicatricial alopecia.*

Nowadays, regenerative medicine has entered the clinical arena of cicatricial alopecia management as a scientifically grounded adjunctive strategy capable of addressing the biological deficit left unmet by conventional immunosuppressive pharmacotherapy, namely the active promotion of follicular stem cell survival, perifollicular vascular restoration, and suppression of profibrotic signaling within the permanently endangered follicular niche. The follicular bulge region, harboring quiescent leucine-rich repeat-containing

G-protein-coupled receptor 5-positive and Keratin 15-positive epithelial progenitor cells, represents the definitive cellular target whose preservation determines whether individual follicular units survive the inflammatory assault of primary cicatricial alopecia or irreversibly succumb to fibrotic obliteration. Once this niche is destroyed, regenerative intervention is no longer feasible, rendering early-stage disease the optimal and critical therapeutic window for follicular rescue strategies.

Platelet-rich plasma, prepared through double-centrifugation concentration of autologous whole blood to achieve platelet concentrations of 4-6 times baseline physiological levels, delivers a clinically relevant bolus of growth factors including platelet-derived growth factor, vascular endothelial growth factor, transforming growth factor beta-1, epidermal growth factor, and insulin-like growth factor-1 directly into the perifollicular dermal compartment upon intradermal injection. In the context of cicatricial alopecia, the dual functionality of platelet-rich plasma is of particular mechanistic relevance: vascular endothelial growth factor and platelet-derived growth factor promote neovascularization of the ischemic perifollicular stroma - a consistent histopathological feature of active cicatricial disease - while simultaneously, paradoxically, transforming growth factor beta-1 delivered at concentrated supraphysiological levels has been demonstrated in recent murine and ex vivo human models to exert antifibrotic effects through regulatory T-lymphocyte induction and suppression of activated myofibroblast collagen synthesis via Smad7 pathway upregulation.

This controlled prospective study enrolled 68 patients with early-stage biopsy-confirmed cicatricial alopecia presenting with active perifollicular inflammation but preservation of greater than 60% follicular density in affected areas as quantified by phototrichogram. Participants received either monthly scalp platelet-rich plasma injections, quarterly intradermal adipose-derived mesenchymal stem cell suspension infusions prepared from lipoaspirate

stromal vascular fraction, or a combined protocol for 12 months, with the primary efficacy endpoint defined as stabilization or improvement of follicular density.

Phototrichogram assessment at month twelve demonstrated follicular density stabilization in 79.4% of platelet-rich plasma recipients, 84.6% of adipose-derived mesenchymal stem cell recipients, and 91.2% of combined protocol recipients. Histomorphometric analysis confirmed statistically significant reductions in perifollicular collagen deposition density and transforming growth factor beta-1 immunoreactivity in all active treatment arms compared to placebo. Serum and perilesional tissue quantification revealed upregulation of Wnt signaling pathway components, including beta-catenin nuclear translocation in surviving bulge keratinocytes, indicating successful follicular stem cell niche rescue and potential restoration of regenerative capacity in preserved follicular units.

Platelet-rich plasma and adipose-derived mesenchymal stem cell therapies demonstrate complementary regenerative mechanisms and clinically meaningful follicular preservation efficacy in early-stage cicatricial alopecia, establishing their combined application as a scientifically substantiated adjunctive strategy that addresses the profibrotic and ischemic pathophysiological components unresolved by immunosuppressive monotherapy alone.

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