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Advances in the Regenerative Management of Striae Distensae: A Comparative Review of Fluid Platelet-Rich Fibrin and Platelet-Rich Plasma

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ABSTRACT
Background: Striae distensae, commonly referred to as stretch marks, are a widespread dermatological concern with significant psychosocial implications, especially among adolescents, pregnant women, and individuals undergoing rapid body changes. Despite being benign, their visible and sometimes extensive appearance can impact self-esteem and quality of life, prompting the search for more effective therapies. Traditional treatments including topical agents, micro-needling, and laser therapy often provide inconsistent results, highlighting the need for innovative approaches. Over recent years, regenerative therapies using autologous blood products have gained prominence in dermatology. Among these, platelet-rich plasma (PRP) and fluid platelet-rich fibrin (f-PRF) have attracted significant attention for their abilities to stimulate tissue repair and remodeling via high concentrations of growth factors and bioactive molecules. PRP is a well-established treatment, known for enhancing collagen production and skin regeneration. f-PRF, a newer, second-generation concentrate, is characterized by a higher yield of platelets and leukocytes, as well as a sustained release of growth factors due to its natural fibrin matrix. This review aims to critically compare the efficacy, mechanisms, clinical outcomes, safety, and patient satisfaction associated with PRP and f-PRF in the management of striae distensae. Through an analysis of the current literature and clinical data, the review identifies existing gaps in knowledge and highlights the need for standardized protocols and larger-scale studies. In conclusion, both PRP and f-PRF represent promising advances in the regenerative management of striae distensae, with f-PRF showing potential for enhanced efficacy due to its unique biological profile. Further research is warranted to establish the optimal treatment modalities and improve patient outcomes.

Keywords*:* Striae Distensae, Platelet-Rich Fibrin, Platelet-Rich Plasma

INTRODUCTION

Striae distensae, more commonly known as stretch marks, represent one of the most prevalent and challenging cutaneous conditions encountered in clinical dermatology. They typically manifest as linear, atrophic bands on the skin, resulting from the breakdown and reorganization of dermal collagen and elastin fibers following rapid or prolonged stretching [1,2]. The incidence of striae distensae is notably high among adolescents undergoing pubertal growth spurts, pregnant women (striae gravidarum), bodybuilders, and individuals experiencing significant weight fluctuations or endocrine disorders [3]. Although these lesions are medically harmless, their visible appearance often leads to substantial psychological distress and diminished self-esteem, fueling the demand for effective therapeutic interventions [4].

Current treatment options for striae distensae are diverse, ranging from topical retinoids and hyaluronic acid-based creams to more advanced procedures like micro-needling, fractional lasers, and radiofrequency therapies [5,6]. However, the majority of these approaches yield modest and unpredictable improvements, and no single treatment has emerged as a universally effective solution. The persistent therapeutic challenge is primarily

due to the complex pathophysiology of striae, characterized by alterations in the dermal extracellular matrix and chronic inflammatory changes that are not easily reversed [7].

In response to these limitations, the field of regenerative medicine has introduced innovative therapies harnessing autologous blood-derived products, specifically platelet-rich plasma (PRP) and fluid platelet-rich fibrin (f-PRF) [8]. These modalities offer the promise of enhancing the skin's intrinsic regenerative capabilities by delivering high concentrations of growth factors and cytokines directly to affected tissues. While PRP has been widely adopted and studied across various dermatological applications, f-PRF represents a newer generation of platelet concentrate, distinguished by its higher cellular content and sustained growth factor release, potentially offering superior tissue remodeling effects [9,10].

Despite their growing popularity, direct comparative data between PRP and f-PRF in the context of striae distensae remain scarce, and standardized protocols are lacking. The aim of this review is to provide a comprehensive, evidence-based comparison of PRP and f-PRF in the management of striae distensae, addressing their mechanisms of action, clinical efficacy, safety profiles, and patient-reported outcomes. Furthermore, this review seeks to identify existing research gaps and suggest future directions for optimizing regenerative approaches in treating this common yet frustrating dermatological concern [11].

Pathophysiology of Striae Distensae

Striae distensae are primarily the result of structural and biochemical changes within the skin's dermal layer. The condition typically develops when the skin undergoes rapid or excessive stretching, surpassing its elastic limit. This stretching can occur due to various physiological events such as pregnancy, puberty, obesity, or rapid muscle growth, leading to a mechanical breakdown of collagen and elastin fibers, which are essential for maintaining skin strength and elasticity [12]. The initial phase, known as striae rubrae, presents as erythematous or violaceous streaks, signifying active inflammation and microtearing within the dermal matrix. Over time, these lesions transition into striae albae, characterized by hypopigmentation, atrophy, and a scar-like appearance, reflecting chronic dermal remodeling and fibrosis [13].

The pathogenesis of striae distensae involves more than mere mechanical factors. At the molecular level, there is a marked reduction in the density and organization of collagen types I and III, alongside a significant decrease in elastin fibers. This leads to thinning of the dermis and a loss of normal skin architecture [14]. In addition, increased activity of matrix metalloproteinases (MMPs), enzymes that degrade extracellular matrix components, further accelerates tissue breakdown and impedes repair. Hormonal influences, particularly elevated levels of glucocorticoids, can also impair fibroblast function and collagen synthesis, predisposing individuals to the development of striae during periods of hormonal flux such as pregnancy or adolescence [15].

Genetic predisposition is another critical factor in the development of striae distensae. Studies have shown that individuals with a family history of striae are more likely to develop them, suggesting the involvement of inherited connective tissue traits or polymorphisms in genes regulating extracellular matrix turnover [16]. Additionally, certain underlying medical conditions—such as Cushing's syndrome or Marfan syndrome—can increase susceptibility due to their effects on skin integrity and connective tissue strength [17].

Histologically, striae distensae exhibit a thin, flattened epidermis with a loss of rete ridges, fragmented collagen bundles arranged parallel to the skin surface, and a notable reduction in elastin content. There is also evidence of inflammatory cell infiltration during the early stages, which diminishes as the lesion matures [18]. These structural changes account for the distinctive clinical progression and long-standing nature of striae, making them difficult to treat with conventional therapies.

Understanding the multifactorial pathophysiology of striae distensae is crucial for developing targeted regenerative interventions. Therapies such as PRP and f-PRF aim to restore dermal matrix integrity by promoting collagen synthesis, fibroblast activation, and angiogenesis, offering hope for more effective and sustained improvement in this challenging condition [19].

Overview of Platelet-Rich Plasma (PRP)

Preparation and Composition

Platelet-rich plasma (PRP) is an autologous blood-derived product created by concentrating platelets from the patient's own blood, resulting in a plasma fraction that contains platelet levels well above physiological

baseline [20]. The standard preparation of PRP typically involves a two-step centrifugation process: the first "soft spin" separates the red blood cells from the plasma and platelets, while the subsequent "hard spin" further concentrates the platelets within the plasma [21]. The resultant PRP contains not only platelets, but also various growth factors and cytokines, such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), and insulin-like growth factor-1 (IGF-1) [22]. The specific composition of PRP can vary significantly depending on the preparation technique, the inclusion or exclusion of leukocytes, and the method of platelet activation, which can all influence clinical outcomes. This variability underscores the importance of protocol standardization in both research and clinical settings [23].

Mechanism of Action

PRP's therapeutic benefits are primarily mediated by the delivery of a concentrated reservoir of platelets and growth factors to areas of tissue injury or degeneration [24]. When activated—either by endogenous collagen exposure in tissues or by exogenous agents like calcium chloride—platelets undergo degranulation, releasing growth factors from their alpha granules [25]. These molecules stimulate dermal fibroblast proliferation and migration, enhance synthesis of collagen and elastin, and promote neovascularization, all of which are vital to tissue regeneration and repair. PRP also exerts anti-inflammatory effects, modulates oxidative stress, and supports remodeling of the extracellular matrix [26]. In striae distensae, these actions can lead to thickening of the atrophic dermis, restoration of normal skin architecture, and improvements in overall appearance and texture.

Previous Clinical Uses in Dermatology

Over the past decade, PRP has been increasingly utilized in a broad range of dermatological and aesthetic procedures. Its established indications include facial rejuvenation, atrophic acne scars, chronic wounds, and hair loss in androgenetic alopecia, reflecting its versatility as a regenerative therapy [27]. Multiple studies have reported PRP's ability to increase dermal thickness, improve elasticity, and enhance overall skin quality through the stimulation of neocollagenesis and angiogenesis[28]. In the context of striae distensae, PRP can be administered as a stand-alone treatment or combined with adjunctive therapies such as micro-needling or fractional lasers. Clinical trials and case series have demonstrated reductions in striae width, improvement in pigmentation, and greater patient satisfaction following PRP treatment, although variability in study protocols and patient characteristics can impact results [29].

Limitations and Considerations

Despite its promising safety profile and ease of use, PRP therapy is not without limitations. The significant heterogeneity in PRP preparation methods—including variations in platelet concentration, presence or absence of leukocytes, and activation techniques—leads to challenges in comparing outcomes across studies and hinders the establishment of consensus guidelines [30]. Patient-related factors, such as age, baseline platelet count, and underlying health conditions, may also affect treatment efficacy. Adverse effects associated with PRP are generally mild and transient, including local erythema, edema, and discomfort at the injection site, but rare complications such as infection or hypersensitivity reactions can occur [31]. As a result, further research is needed to optimize PRP preparation protocols and application methods to maximize clinical benefit in striae distensae.

Overview of Fluid Platelet-Rich Fibrin (f-PRF)

Preparation and Composition

Fluid platelet-rich fibrin (f-PRF) is a second-generation autologous platelet concentrate that builds upon the principles of PRP but offers several important biological and practical advantages [32]. Unlike PRP, the preparation of f-PRF does not require anticoagulants. Instead, a single, low-speed centrifugation is performed on freshly drawn whole blood, which preserves a higher number of platelets, leukocytes, and circulating stem cells within the plasma fraction [33]. Because there are no anticoagulants, the fibrinogen within the plasma remains active and, upon injection, quickly converts into a fibrin network in situ. This fibrin scaffold serves as a natural matrix that supports sustained cellular release and gradual delivery of growth factors [34]. The composition of f-

PRF typically includes an elevated concentration of platelets and leukocytes compared to conventional PRP, along with a physiologically relevant fibrin architecture that is essential for prolonged regenerative activity[35].

Mechanism of Action

The mechanism of action for f-PRF centers on its unique ability to provide a slow, sustained release of bioactive growth factors, such as PDGF, TGF-β, VEGF, and EGF, over several days following injection [36]. The fibrin matrix not only acts as a reservoir for these growth factors but also provides a scaffold that facilitates cellular migration, adhesion, and proliferation within the treated tissue [37]. In addition to platelets, the presence of leukocytes within f-PRF contributes to its regenerative and immunomodulatory properties, as these cells secrete cytokines that further enhance wound healing, angiogenesis, and collagen production [38]. This synergistic cellular and molecular activity is believed to promote more robust dermal remodeling and extracellular matrix regeneration, making f-PRF especially suitable for the management of atrophic skin conditions such as striae distensae [39].

Previous Clinical Uses in Dermatology

Although f-PRF is a relatively newer entrant in the field of regenerative dermatology, its applications have expanded rapidly due to promising preliminary results. Initially used in oral and maxillofacial surgery for bone and soft tissue healing, f-PRF has since been adapted for use in chronic wound care, facial rejuvenation, acne scar revision, and the treatment of other dermatologic scars [40]. Early clinical studies suggest that f-PRF may offer superior results compared to PRP in terms of both efficacy and duration of clinical benefit, likely due to its extended growth factor release and improved cellular content [41]. The injectable form of f-PRF can be used as a monotherapy or in combination with other regenerative modalities, and patients often report greater satisfaction and visible improvement in skin texture and elasticity [42]. Nevertheless, high-quality, comparative clinical trials focusing specifically on striae distensae are still limited, underscoring the need for further research in this area [43].

Comparative Mechanisms of PRP and f-PRF

Both platelet-rich plasma (PRP) and fluid platelet-rich fibrin (f-PRF) are autologous regenerative therapies designed to enhance tissue repair and remodeling, yet their biological properties and clinical effects differ significantly due to variations in their composition, preparation, and mechanisms of action [44]. PRP, as a first-generation concentrate, relies on a high platelet concentration suspended in plasma. Upon activation, PRP delivers an immediate burst release of growth factors, such as PDGF, TGF-β, VEGF, and EGF, which stimulate fibroblast proliferation, neocollagenesis, angiogenesis, and extracellular matrix remodeling [45]. However, this release is largely short-lived, with most growth factors expended within hours to a day after injection. The regenerative response is thus prompt but may lack sustained stimulation for long-term tissue repair [46].

In contrast, f-PRF incorporates not only a higher concentration of platelets but also leukocytes and circulating stem cells, all embedded within a natural fibrin matrix [47]. The unique structure of f-PRF enables a slow, continuous release of growth factors over several days, providing a prolonged stimulatory effect on local tissue repair processes [48]. The fibrin network acts as a biological scaffold, supporting cellular migration, adhesion, and differentiation, which is critical for robust dermal remodeling. Moreover, the presence of leukocytes in f-PRF imparts additional immunomodulatory and antimicrobial properties, potentially reducing inflammation and further supporting healing [49]. The extended growth factor release and enhanced cellular activity are theorized to result in more profound and durable improvements in the treatment of atrophic conditions like striae distensae [50].

Comparative studies suggest that while both PRP and f-PRF can activate similar cellular pathways in the skin, the duration and magnitude of their effects differ due to the differences in delivery kinetics and tissue integration [51]. f-PRF's sustained release profile is considered advantageous for ongoing tissue remodeling, whereas PRP's initial surge may be better suited for rapid wound healing or acute inflammatory conditions. These distinctions underline the importance of individualized therapy selection based on patient needs, clinical goals, and the chronicity of the condition being treated [52]. Ultimately, a deeper understanding of these comparative

mechanisms can help guide optimal application strategies and inform future research in regenerative dermatology [53].

Clinical Evidence: PRP in Striae Distensae

Platelet-rich plasma (PRP) has gained considerable attention as a minimally invasive and biologically potent treatment option for striae distensae, particularly in cases where traditional therapies have yielded suboptimal results [54]. The rationale for PRP use is grounded in its ability to deliver high concentrations of autologous growth factors directly into the dermis, promoting collagen synthesis, tissue remodeling, and skin elasticity—key deficiencies in the pathophysiology of striae [55]. Numerous clinical studies have evaluated the efficacy of PRP, either as a standalone intervention or in combination with adjunctive modalities, such as micro-needling and fractional laser therapy, for the treatment of both striae rubrae and striae albae [56].

In monotherapy settings, PRP injections have demonstrated significant improvement in striae appearance, with reductions in width and length of lesions, enhanced pigmentation, and smoother skin texture reported in treated patients [57]. For instance, split-body trials comparing PRP-injected areas to saline controls have found statistically significant improvements in the PRP-treated sites, as assessed by both investigator and patient satisfaction scores [58]. Histological analyses following PRP therapy reveal increased dermal thickness and collagen fiber density, corroborating clinical findings of improved skin quality [59]. The minimally invasive nature and favorable safety profile of PRP make it an attractive first-line option for individuals seeking non-surgical solutions for stretch marks [60].

Combination approaches have further augmented the clinical outcomes of PRP in striae distensae. When combined with micro-needling, PRP has shown synergistic effects, leading to greater improvements in striae color, texture, and depth compared to either treatment alone [61]. The mechanism underlying this synergy likely stems from micro-needling's ability to induce micro-injuries that facilitate deeper penetration and more effective action of PRP's bioactive components. Fractional laser therapies have also been paired with PRP to accelerate wound healing and minimize post-treatment downtime while enhancing the remodeling of atrophic dermal tissue [62].

Despite these encouraging results, the heterogeneity in PRP preparation methods, administration protocols, and outcome assessment tools remains a major limitation in interpreting and comparing clinical data across studies [63]. There is also variability in patient response based on factors such as skin type, chronicity and stage of striae, and underlying health conditions. Long-term follow-up studies are still needed to assess the durability of PRP's benefits and the optimal treatment regimen in terms of session frequency and maintenance therapy [64]. Nevertheless, the current body of evidence supports the role of PRP as a promising and generally effective approach in the regenerative management of striae distensae [65].

Clinical Evidence: f-PRF in Striae Distensae

Fluid platelet-rich fibrin (f-PRF) represents an emerging modality in the management of striae distensae, leveraging its advanced regenerative properties to address the underlying dermal deficits characteristic of stretch marks [66]. The gradual and sustained release of growth factors from the fibrin matrix, in combination with the action of leukocytes and circulating stem cells, is theorized to result in more effective and prolonged dermal remodeling compared to traditional PRP [67]. Although clinical experience with f-PRF in striae distensae is more limited than with PRP, the existing literature and early clinical reports indicate promising outcomes.

Pilot studies and case series have demonstrated that intradermal injections of f-PRF can lead to significant improvements in the appearance of both striae rubrae and striae albae. These improvements include enhanced skin texture, increased elasticity, and reductions in the width and depth of striae [68]. Histological analysis following f-PRF treatment has shown a marked increase in collagen and elastin fiber density, as well as improved dermal thickness—findings consistent with the regenerative mechanism of action attributed to f-PRF [69]. Patients have also reported high levels of satisfaction, citing visible improvements in striae as well as a reduction in atrophic and hypopigmented areas after a course of f-PRF sessions [70].

The potential advantages of f-PRF over PRP stem from its unique biological properties, including a higher concentration of platelets and leukocytes, the absence of exogenous anticoagulants, and the formation of a natural

fibrin scaffold that supports prolonged growth factor delivery [71]. Comparative observations suggest that the results achieved with f-PRF may be more durable, with patients experiencing ongoing improvement for several months post-treatment [72]. Furthermore, the use of f-PRF is associated with a favorable safety profile, with reported adverse effects generally limited to transient local reactions such as swelling or erythema at the injection sites [73].

Despite these positive findings, the evidence base for f-PRF in the treatment of striae distensae is currently limited by small sample sizes, lack of randomized controlled trials, and short follow-up periods [74]. Additional research is needed to establish standardized protocols for f-PRF preparation and administration, determine optimal treatment intervals, and compare outcomes directly with other regenerative modalities such as PRP [75]. Nevertheless, the available clinical data support the growing role of f-PRF as a safe and potentially more effective alternative in the regenerative treatment of striae distensae, particularly for patients seeking long-lasting results [76].

Comparative Studies: PRP vs f-PRF for Striae Distensae

Direct head-to-head comparisons between platelet-rich plasma (PRP) and fluid platelet-rich fibrin (f-PRF) in the management of striae distensae remain relatively scarce in the published literature, yet emerging studies provide valuable insights into their relative efficacy and clinical outcomes [77]. Available split-lesion and parallel-group studies suggest that both modalities offer significant improvements in the appearance, texture, and elasticity of striae, but subtle differences in the magnitude and duration of their effects are being elucidated [78].

Several comparative studies have observed that both PRP and f-PRF contribute to a reduction in striae width, enhancement of dermal thickness, and increases in collagen content when assessed through clinical scoring, patient self-assessment, and histological analysis [79]. However, f-PRF often demonstrates a slight edge in the durability of results, likely attributed to its sustained growth factor release and the presence of a fibrin matrix that supports extended cellular activity within the dermis [80]. In split-site trials, where one half of a striae lesion is treated with PRP and the other with f-PRF, investigators have reported greater long-term improvement and higher patient satisfaction on the f-PRF-treated side, particularly with respect to reductions in atrophy and hypopigmentation [81].

Moreover, while both therapies are well-tolerated, some evidence suggests that f-PRF may be associated with less post-procedural discomfort and shorter recovery periods, possibly due to its more physiologic composition and natural healing profile [82]. Aesthetic outcomes—such as skin smoothness and blending of striae with surrounding tissue—are frequently rated higher for f-PRF in patient surveys and photographic assessments, although differences do not always reach statistical significance in smaller studies [83].

Despite these trends, the interpretation of comparative data is complicated by methodological heterogeneity, including variation in preparation techniques, injection protocols, striae stage, and assessment tools [84]. Many studies have short follow-up periods, limited sample sizes, or lack blinding and randomization, which may introduce bias and limit generalizability. Notably, the absence of large-scale, multicenter randomized controlled trials means that current recommendations are based on preliminary data and clinical experience rather than high-level evidence [85].

Overall, early comparative evidence suggests that both PRP and f-PRF are valuable options for the regenerative treatment of striae distensae, with f-PRF potentially offering more sustained results and higher patient satisfaction. Further rigorous research is essential to confirm these findings and to refine treatment protocols for optimal outcomes [86].

Safety and Side Effect Profile

Both platelet-rich plasma (PRP) and fluid platelet-rich fibrin (f-PRF) are considered highly safe autologous therapies, as they utilize the patient's own blood components and thus carry minimal risk of immunogenic reactions or disease transmission [87]. The most commonly reported adverse effects for both treatments are mild, localized, and transient. These typically include erythema, swelling, mild discomfort, and occasionally small bruises at the injection sites, which generally resolve within a few days without intervention [88].

A review of published studies and clinical trials confirms that serious complications related to PRP or f-PRF are exceedingly rare [89]. Infrequent cases of infection have been described, most often attributed to breaches in aseptic technique during blood draw or injection rather than the products themselves. Hypersensitivity reactions are also virtually absent, due to the autologous nature of both therapies [90]. Importantly, neither PRP nor f-PRF is associated with systemic side effects, and there are no reports of delayed wound healing, scarring, or pigmentary changes directly resulting from these interventions in the context of striae distensae [91].

Some differences in side effect profile have been noted between PRP and f-PRF, particularly with regard to post-procedural inflammation and healing time. f-PRF, with its absence of exogenous anticoagulants and presence of a fibrin scaffold, may induce a more physiologic and gradual healing response, potentially resulting in less initial swelling and faster tissue integration compared to PRP [92]. Patients treated with f-PRF frequently report shorter downtime and reduced post-injection tenderness, although these advantages are not universally observed and may depend on technique and patient factors [93].

Contraindications for both therapies are similar and include active local infection at the intended treatment site, severe thrombocytopenia, or underlying coagulopathy. Relative contraindications include autoimmune disorders, malignancy, or current use of immunosuppressive medications, which may impact the regenerative response [94]. Pre-treatment patient counseling and thorough medical assessment are therefore recommended to minimize risk and ensure optimal safety outcomes.

Overall, the safety profiles of PRP and f-PRF are among their greatest strengths, supporting their use in the management of striae distensae, particularly for patients seeking low-risk, minimally invasive solutions [95].

Conclusion

In summary, both platelet-rich plasma (PRP) and fluid platelet-rich fibrin (f-PRF) have emerged as promising regenerative therapies for the management of striae distensae, offering substantial improvements in skin texture, elasticity, and the overall appearance of stretch marks. PRP has a well-established record in dermatological practice, with robust evidence supporting its ability to stimulate dermal repair and collagen synthesis, especially when combined with other procedures such as micro-needling or fractional lasers. F-PRF, as a second-generation autologous concentrate, provides several biological advantages—including a higher concentration of platelets and leukocytes, the formation of a natural fibrin scaffold, and the sustained release of growth factors—which appear to translate into more durable and pronounced clinical benefits in preliminary studies.

Comparative research indicates that both modalities are safe, minimally invasive, and associated with high levels of patient satisfaction. However, f-PRF may offer incremental benefits over PRP. Limitations in the current literature, such as heterogeneous methodologies, and limited head-to-head trials, underscore the necessity for larger, well-designed studies to definitively establish the comparative efficacy and optimal application protocols for each treatment.

Ultimately, offering hope for improved outcomes and enhanced quality of life.

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