



Review Article

Extended PRF, a Novel Autologous Scaffold for Periodontology and Implant Dentistry: A Narrative Review

Niyola Crasta, Smitha Shetty

NITTE (Deemed to be University), AB Shetty Memorial Institute of Dental Sciences (ABSMIDS), Department of Periodontics, Deralakatte, Mangalore 575018, India

Received: 22 June 2026

Accepted: 25 June 2026

Published online: 30 June 2026

Keywords: extended PRF, albumin-enriched PRF, bio-heat technology, autologous scaffold, regenerative dentistry

Conventional platelet-rich fibrin (PRF) is widely used in regenerative dentistry; however, its rapid resorption within 2-3 weeks limits its effectiveness as a long-term barrier membrane or volume-stable scaffold. To overcome this limitation, the Albumin-enriched PRF (Alb-PRF) also known as Extended PRF (e-PRF) has been developed using the Bio-Heat technology, which is completely autologous. This narrative review discusses the biological mechanisms, preparation protocols, clinical modifications, applications, and current evidence of Alb-PRF/e-PRF in periodontics and implant dentistry. A systematic literature search was performed in PubMed/MEDLINE, Scopus and Web of Science until June 2026, concentrating on mechanistic studies, preparation methods and clinical studies. The proteolytically resistant three dimensional matrix is prepared by controlled heating of platelet poor plasma at 75°C for 10 minutes. Recombination with concentrated PRF liquid subsequently produces viable platelets, leukocytes and growth factors, leading to a sustained release of TGF- β 1, PDGF and VEGF over 10-14 days and volumetric stability up to 4-6 months. Several clinical iterations have been described such as sole barrier membranes, dual layered configurations, intra-oral bio-filler techniques and functional composites like extended sticky bone and Alb-nCHA-PRF. Recent randomized controlled trials have demonstrated that e-PRF maintains alveolar ridge dimensions similar to collagen membranes, with better early soft-tissue wound healing, significantly more horizontal bone gain in ridge augmentation, and good results in lateral sinus lifts, gingival phenotype modification, papilla reconstruction, and peri-implant defect management. Alb-PRF is a biologically intelligent, fully autologous innovation combining persistent structural stability with prolonged regenerative signalling. It is a natural alternative to xenogenic or synthetic membranes in different clinical indications in periodontology and implant dentistry. More high-quality, long-term, multicenter studies are needed to standardize protocols and optimize clinical applications.

Introduction

The albumin-enriched PRF (Alb-PRF), scientifically called extended platelet-rich fibrin (e-PRF), represents a major advance in autologous platelet concentrate technology to improve the clinical properties of the traditional PRF [1,2]. The second-generation platelet concentrates have proven to be effective biological mediators to enhance the healing process. The main documented drawback is the rapid resorption rate, which usually takes place within 2-3 weeks [3,4]. This short *in vivo* turn-over rate limits the ability of standard PRF to serve as a long term barrier membrane or a stable volume filler in complex regenerative procedures [5-7].

To overcome these limitations, e-PRF utilizes Bio-Heat technology to transform the patient's own blood into a long-lasting biological scaffold [3,7]. The process consists of isolating the platelet-poor plasma

(PPP) layer which is about 60% albumin and heating at 75°C for 10 minutes [3-5]. This heat treatment results in the denaturation of the albumin proteins, breaking weak molecular bonds and rearranging them into a dense and stable tridimensional network [3-5]. This modification improves the *in vivo* stability of the material dramatically, from a few weeks to 4-6 months [1,5,8].

Because the high temperatures required for denaturation destroy the viable cells and growth factors necessary for regeneration, e-PRF is a hybrid biomaterial [3-5]. Once the heated albumin gel has cooled, it is "recharged" by mixing it with liquid PRF (concentrated PRF or C-PRF) harvested from the cell-rich buffy coat layer [1,3,6]. This recombination reintroduces viable platelets, leukocytes, and supraphysiological concentrations of essential growth factors such as TGF- β 1, PDGF, and VEGF, into the stable protein framework [3,5,9].

The resulting material is 100% autologous, biocompatible, and low-

*Corresponding author: Dr. Smitha Shetty
 E-mail address: drsmithshetty@nitte.edu.in

<https://doi.org/10.65795/pa8w2h68>

#20019726©2026 The Author(s). Published by the Society for Biomaterials and Artificial Organs (India), Thiruvananthapuram, India. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the published article in a repository by the author(s) or with their consent.



cost, offering several critical clinical advantages:

- **Extended Longevity:** It maintains volumetric stability for 4 to 6 months, allowing it to function as an effective biological barrier [1,5,10].
- **Sustained Bioactivity:** Unlike the rapid “burst” release of traditional concentrates, e-PRF provides a gradual and prolonged release of regenerative mediators over at least 10–14 days [1,3,11].
- **Clinical Versatility:** It serves as an all-natural alternative to animal-derived collagen or synthetic membranes in guided bone regeneration (GBR), alveolar ridge preservation, and lateral window sinus lifts [3,7].
- **Aesthetic and Orthopedic Applications:** Beyond dentistry, it is utilized as an injectable “Bio-Filler” for facial rejuvenation and as a long-lasting biological growth factor for joint and spinal therapy [3,7].

By integrating the structural persistence of a denatured protein gel with the potent biological signaling of native PRF, e-PRF offers a predictable, completely natural solution for advanced tissue engineering challenges [1,6,8].

Materials and Methods

This narrative review was conducted to synthesize the current evidence on the biologic mechanisms, preparation protocols, clinical modifications, and applications of albumin-enriched platelet-rich fibrin (Alb-PRF), also known as extended platelet-rich fibrin (e-PRF), in regenerative periodontology and implant dentistry.

Literature search strategy

A structured search of the literature was performed in PubMed/MEDLINE, Scopus, and Web of Science databases from inception through June 2026. These were the search terms and combinations were used with Boolean operators (AND, OR): “Alb-PRF”, “albumin-enriched PRF”, “albumin PRF”, “extended PRF”, “e-PRF”, “Bio-Heat PRF”, “albumin gel AND platelet-rich fibrin”, “denatured plasma membrane PRF”, and related Medical Subject Headings (MeSH) terms. Few, Additional relevant articles were identified through manual backward citation searching of key original studies and recent narrative or systematic reviews on platelet concentrates.

Study selection and data synthesis

Titles and abstracts of selected records were screened for relevance. Full texts of potentially eligible articles were then assessed. Data extraction focused on preparation protocols (centrifugation parameters, heating conditions, recombination methods), mechanistic findings (growth factor release kinetics, cellular responses, degradation profiles), clinical outcomes (soft-tissue healing, ridge dimensional changes, bone gain, aesthetic scores), and safety/complications. Extracted information was organized thematically into sections covering biologic mechanisms, preparation and modifications, clinical applications, and a summary of key clinical studies. Because of substantial heterogeneity in study designs, outcome measures, and follow-up durations, no formal meta-analysis or quantitative synthesis was performed. Findings were narratively integrated to highlight both the mechanistic rationale and clinical translation of Alb-PRF technology. Discrepancies in study interpretation were resolved through discussion among the authors.

Mechanistic evidence of e-PRF

Mechanistic evidence indicates that the distinctive properties of albumin-enriched platelet-rich fibrin (Alb-PRF), also known as extended PRF (e-PRF), arise from the thermal transformation of plasma proteins into a stable scaffold that preserves and gradually releases autologous biological mediators.

Thermal denaturation and molecular restructuring

The principal mechanism responsible for the extended longevity of Alb-PRF involves controlled heating of platelet-poor plasma (PPP) at 75°C for 10 minutes. This thermal treatment disrupts weak intramolecular

interactions, including hydrogen bonds, within the albumin molecule [4,5]. The denatured proteins subsequently reorganize and aggregate through the formation of new disulfide bonds and hydrophobic interactions, converting the liquid plasma into a densely organized, three-dimensional protein network (albumin gel) [3,12]. The resulting matrix exhibits substantially greater resistance to degradation than the fibrin network of conventional PRF [3,4].

Inactivation of fibrinolytic enzymes

Thermal processing inactivates key enzymes that mediate matrix biodegradation. In particular, heating denatures plasminogen, the heat-labile zymogen responsible for fibrinolysis [13,14]. Because these intrinsic fibrinolytic enzymes are inactivated, the albumin-reinforced matrix acquires high resistance to enzymatic digestion. This modification prolongs *in vivo* stability from the 2–3 weeks characteristic of standard PRF to 4–6 months [4,13].

Hybrid recombination to restore bioactivity

Heating of PPP abolishes cellular viability and many bioactive components within that plasma fraction. To restore regenerative capacity, the cooled albumin gel is recombined with liquid concentrated PRF (C-PRF) harvested from the cell-rich buffy-coat layer [4,13,14]. This recombination step reintroduces viable platelets and leukocytes into the stable albumin framework, generating a biphasic composite that combines structural durability with cellular bioactivity [5,13].

Sustained release kinetics of regenerative mediators

The compact ultrastructure of the albumin-reinforced matrix modifies the release profile of embedded growth factors. Unlike the rapid burst release typical of standard PRF, Alb-PRF permits gradual and sustained liberation of key mediators, including transforming growth factor- β 1 (TGF- β 1), platelet-derived growth factor isoforms (PDGF-AA, -AB, -BB), vascular endothelial growth factor (VEGF), and insulin-like growth factor-1 (IGF-1), over a minimum of 10–14 days [5,11]. The prolonged structural persistence of the gel ensures that these factors are released progressively as the albumin scaffold undergoes slow resorption [5].

Cellular and molecular signaling effects

In vitro studies have shown that Alb-PRF modulates host-cell responses relevant to soft- and hard-tissue repair. Exposure of gingival fibroblasts to Alb-PRF significantly upregulates the expression of TGF- β 1 and type I collagen (COL1A2) [5,15]. In osteoblast-like cells, the material increases alkaline phosphatase (ALP) activity and elevates the osteoprotegerin (OPG)/receptor activator of nuclear factor κ B ligand (RANKL) mRNA ratio, thereby favoring osteoblast activity while suppressing osteoclast-mediated bone resorption [15]. In addition, the reintroduced buffy-coat component supplies catalase activity capable of neutralizing hydrogen peroxide and attenuating local oxidative stress [3,16].

Ultrastructural barrier properties

Scanning electron microscopy demonstrates that the denatured protein forms a continuous, dense surface layer that coats the underlying fibrin fibers, resulting in markedly reduced surface porosity [15,17]. This physical configuration functions as a barrier that limits premature soft-tissue infiltration while preserving a microenvironment conducive to orderly and controlled tissue regeneration [11,12].

Preparation protocol

Alb-PRF (also known as extended platelet-rich fibrin, e-PRF) was prepared according to the following protocol to generate a stable autologous biomaterial with prolonged volume stability and resorption time. Peripheral blood (9–10 mL) was collected from each patient into additive-free tubes and immediately centrifuged horizontally at 700 g for 8 minutes. This resulted in clear separation into an upper yellow plasma layer and a lower red blood cell layer. The uppermost 2–4 mL of the plasma layer (platelet-poor plasma, PPP) was aspirated into a sterile syringe. The remaining platelet-rich layer adjacent to the buffy coat, containing concentrated platelets and leukocytes (concentrated liquid PRF,

C-PRF), was transferred into a separate syringe. The C-PRF fraction was deliberately left unheated to preserve its biological activity. The heating device was preheated to 75°C. Syringes containing the PPP were placed in the device and heated for 10 minutes. This thermal treatment denatured the albumin, converting it into a dense, stable albumin gel matrix that imparts structural volume and significantly prolongs resorption of the final construct [3]. Following heating, the albumin gel syringes were removed and cooled for 2 minutes in a dedicated cooling device or allowed to equilibrate to room temperature over approximately 10 minutes. The cooled albumin gel syringe was then connected to the C-PRF syringe using a female-to-female Luer-lock connector. The two components were homogenized by repeated back-and-forth transfer between the syringes approximately 10 times until a uniform mixture was obtained [3]. To preserve the viability of platelets and leukocytes within the C-PRF fraction during recombination, the homogenization was performed gently using low extrusion pressure over approximately 10 back-and-forth transfers between the syringes. This standard clinical technique minimizes mechanical shear stress on cellular components while achieving a homogeneous mixture. The procedure has been shown in referenced studies to maintain the biological activity of the incorporated cells, as evidenced by prolonged growth factor release profiles [5,11].

Modifications and iterations of e-PRF

Several modifications of Alb-PRF (also termed e-PRF or extended PRF) have been developed to improve clinical handling, reduce chairside time, enhance biological performance, and expand therapeutic versatility. These adaptations can be broadly classified into clinical application techniques, functional composites, and technical processing variations.

Clinical application techniques

Four principal clinical iterations have been described. *Sole Barrier Membrane*: Alb-PRF is prepared extra-orally and applied as a standalone autologous barrier membrane directly over bone graft material [18]. *Dual-Layer Configuration*: A solid PRF membrane is placed over the Alb-PRF membrane. This layered approach provides superior mechanical strength and an early burst release of growth factors from the solid PRF, while the underlying Alb-PRF ensures prolonged structural stability and sustained bioactivity [6,18]. *Intra-oral Bio-Filler*: The Alb-PRF is applied to the surgical site in a gel or liquid state, allowing final fibrin polymerization to occur intra-orally at body temperature. This technique reduces chairside time by approximately 15 minutes [6,18]. *Intra-oral Bio-Filler with Solid PRF Overlay*: The intra-oral bio-filler method is combined with placement of a solid PRF membrane over the gel, offering additional protection against disruption by saliva or mechanical movement while maintaining the benefits of both components [6,18].

Functional composites

Alb-PRF has been combined with various biomaterials to augment its osteoconductive and antimicrobial properties. *Extended Sticky Bone*: Alb-PRF is mixed with particulate bone grafts to form an extended version of sticky bone. In contrast to conventional sticky bone (standard PRF + graft), which resorbs within 8–12 days, the Alb-PRF-based composite maintains structural integrity and biological activity for 4–6 months [19]. *Alb-nCHA-PRF*: Carbonated nanostructured hydroxyapatite (nCHA) microspheres are incorporated into the Alb-PRF matrix to enhance osteoconductivity [8]. *Alb-nCHA-PRF with Doxycycline*: The nCHA microspheres are pre-incubated with doxycycline before incorporation into the Alb-PRF matrix, creating a multifunctional scaffold that simultaneously delivers regenerative signals and sustained local antimicrobial activity [8].

Technical processing modifications

Alternative technical approaches have been explored to modify the ultrastructure, mechanical properties, and handling of Alb-PRF. *Glass Vessel Activation*: Some protocols substitute syringe mixing with a glass vessel to promote denser fibrin polymerization through contact activation while preserving the viability of incorporated cells [12]. *Mixing Methods*: Two primary techniques are used to combine the heated albumin gel with

liquid PRF. Female-to-female Luer-lock syringe technique, involving repeated back-and-forth transfer (approximately 10 cycles) to achieve a homogeneous mixture [18], and Tray saturation, in which the condensed albumin gel is placed in a custom tray and saturated with liquid PRF [18]. *HypACT Inject System*: Although mechanistically distinct from the standard Alb-PRF thermal protocol, the hypACT Inject system utilizes a freeze–thaw process within a closed syringe system to produce PRF membranes with higher tensile strength and lower degradation rates [2,9].

Applications in dentistry

In the dental field, e-PRF is primarily used as an alternative to resorbable collagen or non-resorbable membranes.

- **Alveolar Ridge Preservation**: e-PRF is used as a **solo barrier membrane** over bone grafts (often “sticky bone”) in extraction sockets. It effectively maintains ridge dimensions, prevents soft tissue infiltration [6,8,11,20]. It has been shown to improve early soft-tissue wound healing compared to traditional collagen membranes [6,11].
- **Guided Bone Regeneration (GBR)**: It serves as a substitute for collagen membranes in complex GBR procedures. It is particularly useful when placed over **titanium mesh** to minimize the high risk of mesh exposure associated with standard techniques [5,9].
- **Sinus Floor Elevation**: e-PRF is utilized to **cover the lateral window** in sinus lifts, offering a long-lasting barrier that reduces postoperative discomfort compared to synthetic options. Some studies also report using it as a **standalone graft material** within the sinus, achieving significant vertical bone gain [11,18].
- **Periodontal Plastic Surgery**:
 - **Gingival Recession Coverage**: It is used as a substitute for connective tissue grafts or collagen membranes in tunneling procedures [8,18,20].
 - **Gingival Phenotype Modification**: It successfully increases gingival thickness in patients with thin phenotypes [11,18,20].
 - **Papilla Reconstruction**: e-PRF can be injected into deficient interdental spaces to treat “black triangles” [3,11].
 - **Peri-implant Defects**: It is used to treat socket wall defects around immediate dental implants to enhance aesthetic outcomes and reduce marginal bone loss [1,7].

Advanced and emerging applications

Functionalized Drug Delivery: Because albumin can carry various drugs, e-PRF is being engineered as a multifunctional scaffold for the local delivery of antibiotics (e.g., doxycycline), vitamins, or extracellular vesicles to simultaneously support regeneration and control infection [8].

Discussion

Key mechanistic, preclinical, and clinical studies evaluating albumin-enriched platelet-rich fibrin (Alb-PRF), also known as extended PRF (e-PRF), are summarized in table 1. A major limitation of conventional platelet-rich fibrin (PRF) is its relatively rapid resorption, typically occurring within 2–3 weeks. This timeframe is often insufficient for clinical applications requiring prolonged barrier function or sustained volume stability [6,8]. Mourão et al. (2018) first demonstrated that heating platelet-poor plasma (PPP) induces albumin denaturation, thereby generating a stable gel matrix that can be subsequently enriched with liquid PRF [1,26]. This approach was further validated in an animal study by Gheno et al. (2020), in which Alb-PRF maintained volume stability for 4–6 months in a nude mouse model, whereas both leukocyte-rich PRF (L-PRF) and heat-compressed PRF (H-PRF) underwent complete resorption within 21 days [3,9,10].

Growth factor kinetics and soft tissue response

In contrast to the rapid burst release characteristic of earlier platelet concentrates, Alb-PRF exhibits a more gradual and sustained release of growth factors [5,11,21]. Fujioka-Kobayashi et al. (2021) reported that Alb-PRF released substantial quantities of transforming growth factor- β 1 (TGF- β 1) and platelet-derived growth factor (PDGF) over a 10-day

Table 1: Summary of selected key studies on extended platelet-rich fibrin (e-PRF) or albumin-enriched PRF (Alb-PRF), including study type, applications, comparators, and main findings

Author (Year)	Study Type	Clinical/Research Application	Comparison Group	Key Outcomes and Findings
Gheno et al. (2020)	Animal (Nude Mice)	Biocompatibility and Biodegradation	L-PRF and H-PRF	Demonstrated that Alb-PRF remains volume-stable for 4–6 months, while standard PRF variants resorb within 3 weeks.(9)
Fujioka-Kobayashi et al. (2020)	In Vitro	Growth Factor (GF) Kinetics & Fibroblast Activity	Control / Standard PRF	Characterized a slow, sustained release of GFs (TGF- β 1, PDGF) over 10 days; significantly stimulated gingival fibroblast proliferation and collagen mRNA expression.(5)
Javid et al. (2023)	Split-mouth RCT	Mandibular 3rd Molar Extraction Sockets	L-PRF	Alb-PRF showed a significant reduction in swelling/edema at day 7 and faster epithelial closure compared to L-PRF.(21)
Estrin et al. (2026)	Single-center RCT	Alveolar Ridge Preservation	Collagen Membrane	All 4 e-PRF iterations performed comparably to collagen in maintaining ridge dimensions; e-PRF showed superior early soft-tissue wound healing.(6)
Abla et al. (2026)	RCT	Horizontal Ridge Augmentation	Conventional PRF	e-PRF provided significantly greater horizontal bone gain at 6 months (2.28 mm vs. 0.75 mm for standard PRF).(22)
Kumari et al. (2025)	RCT	Periodontal Intrabony Defects (IBDs)	Conventional PRF	Alb-PRF resulted in a modest but consistent benefit in reducing Probing Pocket Depth (PPD) and gaining Clinical Attachment Level (CAL).(23)
Alsabahi et al. (2026)	Preliminary RCT	Peri-implant Socket Wall Defects	Collagen Membrane	Both were effective, but Alb-PRF yielded superior aesthetic scores (PES) and significantly less marginal bone loss.(1)
Abdulkhak et al. (2024)	RCT	Gingival Phenotype Modification	Connective Tissue Graft (CTG)	Alb-PRF significantly increased gingival thickness at 3 months; CTG was superior only for keratinized tissue width.(24)
Estrin et al. (2024)	Case Series	Lateral Window Sinus Lift	Solo Barrier (e-PRF)	e-PRF was successful as a 100% autologous barrier; mean endosinus bone gain of 8.0 mm and 100% implant survival at 6 months.(7)
Lourenço et al. (2024)	In Vitro / Preclinical	Osteoblast Behavior	Conventional PRF	Alb-PRF exhibited higher alkaline phosphatase (ALP) activity and significantly increased the OPG/RANKL ratio, suggesting enhanced osteogenic potential.(15)
Vadiati Saberi et al. (2024)	RCT	Interdental Papilla Reconstruction	Hyaluronic Acid	Injection of Alb-PRF gel significantly increased papillary height to treat "black triangles".(25)
Shokry et al. (2025)	RCT	Jaw Cyst Enucleation	Blood Clot	No significant difference in bone regeneration volume at 6 months compared to standard blood clots.(26)
Shen et al. (2026)	In Vitro	Endothelial (HUVEC) Function	PRP and H-PRF	Alb-PRF outperformed PRP and H-PRF in cell migration, proliferation, and protection against inflammatory damage (LPS-induced). (27)
Mourão et al. (2018)	Proof of Concept	Modified CGF + Albumin Gel (APAG)	Liquid PRF	First study to demonstrate a stable, moldable membrane with denser ultrastructure and GF release for 7 days. (12)

period, resulting in significant upregulation of collagen synthesis and proliferation in gingival fibroblasts [5]. These biological properties have been associated with favourable clinical soft tissue outcomes. Javid et al. (2023) observed accelerated epithelial closure together with reduced postoperative swelling and pain following third molar extraction [21]. In addition, Abdulkhak et al. (2024) and Vadiati Saberi et al. (2024) demonstrated the efficacy of Alb-PRF as a bio-filler, reporting significant gains in gingival thickness and interdental papilla volume [24,25].

Hard tissue regeneration and bone gain

Although early systematic reviews primarily characterised Alb-PRF as a soft-tissue-modulating adjunct, accumulating evidence from randomised controlled trials indicates meaningful hard-tissue regenerative potential [11]. Abla et al. (2026) reported significantly greater horizontal bone gain with e-PRF (2.28 mm) compared with standard PRF (0.75 mm) in ridge augmentation procedures [22]. In sinus floor elevation, Barakat et al. (2025) achieved approximately 5 mm of vertical bone gain using Alb-PRF alone [28]. Mechanistic support is provided by Lourenço et al. (2024), who demonstrated that Alb-PRF enhances alkaline phosphatase activity and favourably modulates the osteoprotegerin/receptor activator of nuclear factor kappa-B ligand (OPG/RANKL) ratio, thereby promoting osteogenesis while inhibiting osteoclast-mediated resorption [15]. However, Shokry et al. (2025) found no additional bone gain when Alb-PRF was applied in cystic cavities compared with a simple blood clot.

These contrasting outcomes, significant horizontal bone gain in non-contained ridge dehiscence defects (Abla et al., 2026) versus limited added benefit in well-protected cystic defects, underscore a key biomaterial principle: e-PRF functions primarily as a space-maintaining physical barrier and a sustained-release delivery matrix for autologous growth factors, rather than as an inherently osteoinductive material. Its clinical advantages are therefore most pronounced in volume-critical or non-contained defects where prolonged space maintenance is essential to support orderly tissue regeneration and prevent soft-tissue collapse [22,26].

Comparative status as a biological barrier

Recent investigations have positioned e-PRF as a fully autologous alternative to commercially available collagen membranes. Estrin et al. (2026) demonstrated that various formulations of e-PRF achieved comparable maintenance of ridge dimensions to collagen membranes while providing superior early soft-tissue wound healing.(6) Consistent findings were reported by Alsabahi et al. (2026) and Abdelsamea et al. (2025), who observed that Alb-PRF performed equivalently or favourably to synthetic and dentine-derived membranes in reducing marginal bone loss and supporting long-term peri-implant stability [1,4].

Emerging biological rescue and angiogenesis

Emerging evidence indicates that Alb-PRF may confer protective effects in compromised or inflammatory microenvironments. Shen et al.

(2026) showed that Alb-PRF promoted endothelial cell function more effectively than PRP or H-PRF and, importantly, rescued cells from lipopolysaccharide (LPS)-induced damage [27]. These findings suggest that Alb-PRF may offer therapeutic advantages in regenerative procedures performed at sites with underlying inflammation or compromised vascularity [27].

Conclusion

In conclusion, albumin-enriched platelet-rich fibrin (Alb-PRF), also known as extended PRF (e-PRF), represents a significant evolution in autologous platelet concentrate technology. By employing controlled thermal processing of platelet-poor plasma to create a stable, proteolytically resistant albumin matrix that is subsequently recombined with concentrated PRF, this hybrid biomaterial successfully overcomes the principal limitation of conventional PRF, its rapid resorption within 2–3 weeks. The resulting construct provides extended volumetric stability for 4–6 months together with sustained release of key growth factors over a minimum of 10–14 days, while remaining entirely autologous, biocompatible, and cost-effective [3].

The body of mechanistic, preclinical, and clinical evidence compiled in this review demonstrates that e-PRF functions effectively as a long-lasting biological barrier and bioactive scaffold across a wide spectrum of regenerative applications. Randomized controlled trials and supporting studies have shown that various clinical iterations of e-PRF achieve ridge-dimension maintenance comparable to collagen membranes, with superior early soft-tissue wound healing, while also delivering meaningful hard-tissue gains in horizontal ridge augmentation and sinus floor elevation [6,11,18,20]. Additional benefits have been documented in periodontal plastic surgery (gingival phenotype modification, recession coverage, and papilla reconstruction) and in the management of peri-implant socket defects, where aesthetic outcomes and marginal bone preservation were favorably influenced [7]. Emerging data further suggest protective effects in inflamed microenvironments and potential for functionalized drug delivery [8].

Although these findings are promising, further high-quality, long-term, and multicenter studies are warranted to optimize and standardize preparation protocols, validate durability of outcomes beyond the initial healing phase, and clearly define the most appropriate indications for each clinical iteration. Nevertheless, e-PRF constitutes a biologically intelligent and versatile addition to the regenerative armamentarium—one that successfully integrates structural longevity with potent, sustained cellular signaling and offers a fully natural alternative to xenogenic or synthetic membranes in contemporary periodontology and implant dentistry.

Acknowledgements

SS was involved in designing the concept of the review followed by conducting the literature search and drafting the initial manuscript. SS and NC were involved in revising and editing the manuscript. Data authentication is not applicable. All the authors reviewed, and have read and approved the final manuscript

References

- Alsabahi H, Mowafey B, Kandil I, Elgohary N, Youssef J. Clinical and radiographic evaluation of autologous albumin-rich platelet-rich fibrin membrane versus synthetic collagen membrane for immediate dental implant placement in the maxillary esthetic zone: a preliminary randomized clinical trial. *BMC Oral Health*. 26(1), 292 (2026).
- Houshmand B, Ardakani MT, Armandi F, Moscovichi A, Nazari A, Ai J, et al. *In vitro* ultrastructure and biodegradation of activated plasma albumin gel derived from human samples: A prospective observational study. *Clin Adv Periodontics*. 16(1), 205–12 (2026).
- Miron RJ, Pikos MA, Estrin NE, Kobayashi Fujioka M, Espinoza AR, Basma H, et al. Extended platelet rich fibrin. *Periodontology*. 94(1), 114–30 (2024).
- Abdelsamea SE, Alruwaili AM, El-Gohary N, Elsheikh HAE. Dentine-derived barrier membrane versus extended platelet-rich fibrin for guided bone regeneration: a 2-year randomized clinical trial. *BMC Oral Health*. 26(1), 960 (2026).
- Fujioka-Kobayashi M, Schaller B, Mourão CFDAB, Zhang Y, Sculean A, Miron RJ. Biological characterization of an injectable platelet-rich fibrin mixture consisting of autologous albumin gel and liquid platelet-rich fibrin (Alb-PRF). *Platelets*. 32(1), 74–81 (2021).
- Estrin NE, Ahmad P, Tran TB, Espinoza AR, Holmes R, Imber JC, et al. The Evolution of Extended Platelet-Rich Fibrin Membranes for Socket Grafting: Part Two: A Randomized Clinical Trial Comparing These Membranes with Collagen Membranes. *Dentistry Journal*. 14(1), 45 (2026).
- Estrin NE, Basma H, Espinoza AR, Pinto MAC, Pikos MA, Miron RJ. Extended Platelet Rich Fibrin as a Membrane for Lateral Window Sinus Lifts: A Case Series. *Clin Implant Dent Rel Res*. 27(1), e13427 (2025).
- Rocha NRS, Lourenço ES, Lima VHDS, Soriano CA, Rossi AM, Spiegel CN, et al. Alb-PRF Hybrid Membranes Functionalized with Carbonated Hydroxyapatite and Doxycycline for Bone Regeneration and Antimicrobial Control: An *In vitro* Study. *IJMS*. 27(8), 3639 (2026).
- Gheno E, Mourão CFDAB, Mello-Machado RCD, Stellet Lourenço E, Miron RJ, Catarino KFF, et al. *In vitro* evaluation of the biocompatibility and biodegradation of a new denatured plasma membrane combined with liquid PRF (Alb-PRF). *Platelets*. 32(4), 542–54 (2021).
- Song P, He D, Ren S, Fan L, Sun J. Platelet-rich fibrin in dentistry. *J Appl Biomater Funct Mater*. 22808000241299588 (2024).
- Býčákýođlu HA, Çolak G. Clinical effectiveness of albumin-enriched platelet-rich fibrin (Alb-PRF) in periodontal and peri-implant regenerative surgery: a systematic review. *Odontology*. 15, 1–3 (2026).
- Barros Mourão CDA, Gheno E, Lourenço E, Barbosa RL, Kurtzman G, Javid K, et al. Characterization of a new membrane from concentrated growth factors associated with denatured Albumin (Alb-CGF) for clinical applications: A preliminary study. *Int J Growth Factors Stem Cells Dent*. 1(2), 64 (2018).
- Kargarpour Z, Nasirzade J, Panahipour L, Miron RJ, Gruber R. Liquid Platelet-Rich Fibrin and Heat-Coagulated Albumin Gel: Bioassays for TGF- β Activity. *Materials*. 13(16), 3466 (2020).
- Huang X, Panahipour L, Rassi Faghihi D, Miron RJ, Gruber R. Extended PRF: Impact of Heat on Gene Expression in Gingival Fibroblasts. *IJMS*. 26(18), 9120 (2025).
- Lourenço ES, Rocha NRS, De Lima Barbosa R, Mello-Machado RC, De Souza Lima VH, Leite PEC, et al. Investigating the Biological Efficacy of Albumin-Enriched Platelet-Rich Fibrin (Alb-PRF): A Study on Cytokine Dynamics and Osteoblast Behavior. *IJMS*. 25(21), 11531 (2024).
- Kargarpour Z, Nasirzade J, Di Summa F, Panahipour L, Miron RJ, Gruber R. Platelet-Rich Fibrin Can Neutralize Hydrogen Peroxide-Induced Cell Death in Gingival Fibroblasts. *Antioxidants*. 9(6), 560 (2020).
- Kawase T, Kamiya M, Kobayashi M, Tanaka T, Okuda K, Wolff LF, et al. The heat-compression technique for the conversion of platelet-rich fibrin preparation to a barrier membrane with a reduced rate of biodegradation: Heat-compressed PRF as an effective barrier membrane. *J Biomed Mater Res*. 103(4), 825–31 (2015).
- Estrin NE, Espinoza AR, Ahmad P, Imber JC, Farshidfar N, Miron RJ. The Evolution of Extended Platelet-Rich Fibrin Membranes for Socket Grafting: Part One: Technical Development of Protocols. *Dentistry Journal*. 13(12), 604 (2025).
- Alruwaili AQA, Ahmed DrWS, Yaseen DrAA, Elgohary DrN. Extended Sticky Bone Versus Ethoss Bone Graft In Horizontal Ridge Augmentation With Simultaneous Implant Placement In The Maxillary Esthetic Zone. *AJBR [Internet]*. 28(4S), 969-74 (2025).
- Estrin NE, Tran TB, Espinoza AR, Ahmad P, Farshidfar N, Holmes R, et al. Safety and Feasibility of Extended Platelet Rich Fibrin as a Solo Barrier Membrane for Ridge Preservation: A Case Series. *Clinical & Exp Dental Res*. 12(1), e70282 (2026).
- Javid K, Mourão CF, Mello-Machado RC, Sartoretto SC, Torres M, Stellet Lourenço E, et al. Clinical and Biochemical Evaluation of the Use of Alb-PRF versus L-PRF in Mandibular Third Molar Extractions: A Split-Mouth Randomized Clinical Trial. *JFB*. 14(10), 505 (2023). doi:10.3390/jfb14100505
- Abla MMA, Shaaban AM, Younis PA. Comparing two types of platelet-rich fibrin membranes in the management of dehiscence defects with simultaneous implant placement in the posterior mandible: a randomized controlled trial. *BMC Oral Health*. 26(1), 591 (2026).
- Kumari S, Sharma AK, Sunil MKS, Koppula SK, Sharma S. A Randomized Controlled Study Comparing Albumin-Enriched Platelet-Rich Fibrin and Conventional Platelet-Rich Fibrin for the Treatment of Intraony Defects. *Journal of Pharmacy and Bioallied Sciences*. 17(Suppl 2), S1619–21 (2025). doi:10.4103/jpbs.jpbs_190_25
- Abdulhak S, Kassem T, Tolibah YA. Comparison Between Autologous Albumin Gel and Liquid Platelet-Rich Fibrin Mixture Versus Connective Tissue Graft to Modify the Gingival Phenotype: A Randomized Controlled Trial. *Cureus*. 16(6) (2024).
- Vadiati Saberi B, Khalighi Sigaroudi A, Kamani M, Rafiei E. Comparison of the effect of albumin with platelet-rich fibrin (Alb-PRF) gel and hyaluronic acid gel injection on interdental papilla reconstruction: A randomized clinical trial. *J Adv Periodontol Implant Dent*. 16(2), 109–15 (2024).
- Shokry MMEM, Melek LNF, Amer TA. Three-dimensional volumetric analysis of bone regeneration following jaw cyst enucleation with and without an autologous albumin gel-platelet-rich fibrin mixture (Alb-PRF): a randomized controlled clinical trial. *BMC Oral Health*. 25(1), 693 (2025).
- Shen F, Chai J, Wei M, Qian X, Shen M. Next-generation platelet concentrate: Alb-PRF outperformed PRP and H-PRF in promoting endothelial function and wound healing. *Sci Rep*. 16(1), 13934 (2026).
- Barakat M, Khalil A, Albash Z. Efficacy of platelet-rich albumin and fibrin gel in two-stage lateral sinus lift: a prospective study. *Annals of Medicine & Surgery*. 87(9), 5409–16 (2025).