ISSN: 2755-0141

Japan Journal of Clinical & Medical Research

Review Article

Open Access

Biologic Alchemy: Transforming OMFS with Platelet-Derived Regenerative Therapies

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ABSTRACT

Autologous platelet concentrates specifically Platelet-Rich Plasma (PRP), Platelet-Rich Fibrin (PRF), and Growth Factor Concentrate (GFC) represent a paradigm shift in regenerative strategies within Oral and Maxillofacial Surgery (OMFS). These biologically active formulations are derived from the patient's own blood and are rich in a spectrum of growth factors, cytokines, and cellular mediators that orchestrate tissue repair and regeneration. By delivering a concentrated payload of bioactive molecules directly to surgical sites, they stimulate angiogenesis, modulate inflammation, and accelerate the proliferation and differentiation of progenitor cells. This targeted enhancement of the healing cascade makes platelet-derived therapies particularly valuable in clinical scenarios where tissue regeneration is suboptimal such as in compromised bone beds, irradiated tissues, or complex reconstructive procedures. Their versatility spans a wide array of OMFS applications, including alveolar ridge preservation, sinus augmentation, implantology, and the management of osteonecrosis, offering clinicians a biologically intelligent adjunct to conventional surgical techniques.

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Received: September 10, 2025; **Accepted:** September 15, 2025; **Published:** September 22, 2025

Platelet-Rich Plasma (PRP)

Platelet-rich plasma (PRP) is considered the first generation of autologous platelet concentrates used in regenerative medicine and oral surgery. It is prepared from a patient's own blood and contains a significantly higher concentration of platelets typically three to five times more than what is normally found in circulating blood. These platelets are not just involved in clotting; they are packed with powerful growth factors that play essential roles in healing and tissue regeneration. Among the most important are Platelet-Derived Growth Factor (PDGF), which stimulates cell growth and division; Transforming Growth Factor-beta (TGF-β), which helps regulate inflammation and promotes tissue repair; Vascular Endothelial Growth Factor (VEGF), which encourages the formation of new blood vessels; and Epidermal Growth Factor (EGF), which supports skin and mucosal healing [1,2].

To prepare PRP, blood is first drawn from the patient and mixed with an anticoagulant commonly Acid Citrate Dextrose Solution A (ACD-A) to prevent clotting during processing. The blood is then subjected to a two-step centrifugation process. The first spin separates the red blood cells from the plasma, and the second spin concentrates the platelets within the plasma. This process is typically carried out at room temperature, around 20 to 24 degrees Celsius, to maintain the viability of the platelets [3].

Depending on the method of preparation and the clinical need, PRP can be further classified into two types: leucocyte-rich PRP (L-PRP), which contains white blood cells along with platelets, and leucocyte-poor PRP (P-PRP), which is more refined and contains fewer inflammatory cells [4]. Each type has its own advantages. L-PRP may be more suitable for stimulating immune responses and promoting healing in infected or inflamed tissues, while P-PRP is often preferred in aesthetic or minimally invasive procedures where reduced inflammation is desired.

PRP has gained widespread use in oral and maxillofacial surgery due to its ability to enhance healing in both hard and soft tissues. It is commonly used in procedures such as tooth extractions, implant placement, bone grafting, and treatment of osteonecrosis. By delivering concentrated growth factors directly to the surgical site, PRP helps accelerate tissue regeneration, reduce postoperative pain, and improve overall clinical outcomes [5].

Clinical Applications in OMFS

Socket Preservation & Alveolitis Prevention

What happens: After a tooth is extracted, the space (socket) can be slow to heal and sometimes painful especially if the blood clot dissolves too early, leading to a condition called alveolitis or "dry socket."

How PRP helps:

- PRP contains growth factors that speed up the formation of new tissue.

- It helps the gum tissue close over the socket faster (epithelial closure).
- It reduces pain and swelling by promoting better blood flow and healing.
- Studies show PRP significantly lowers the risk of dry socket, especially in high-risk patients like smokers or those with poor circulation.

Bone Grafting & Sinus Lift

What happens: In procedures like sinus lifts or bone grafting (often done before placing implants), surgeons add bone material to areas with insufficient bone.

How PRP helps:

- PRP acts like a biological fertilizer—it's rich in growth factors that stimulate bone cells.
- When mixed with bone graft materials like hydroxyapatite or allografts, PRP improves how well the graft integrates with the existing bone.
- It boosts new bone formation and shortens healing time.
- PRP also enhances blood supply in the sinus area, which is normally poorly vascularized.

Implantology

What happens: Dental implants need to fuse with the jawbone—a process called osseointegration.

How PRP helps:

- PRP releases growth factors that attract bone-forming cells to the implant site.
- It improves the stability of the implant by accelerating bone bonding.
- Healing is faster, and there's less postoperative discomfort.
- When PRP is applied to the implant surface or surrounding bone, it enhances both soft tissue and bone regeneration.

BRONJ Management (Bisphosphonate-Related Osteonecrosis of the Jaw)

What happens: Some patients taking medications like bisphosphonates (for osteoporosis or cancer) can develop jawbone necrosis, where bone dies due to poor blood supply.

How PRP helps:

- PRP promotes healing of the mucosa (gum tissue) over necrotic bone.
- It helps reduce inflammation and encourages new blood vessel formation.
- When used after surgical cleaning of the dead bone, PRP can improve outcomes and reduce recurrence.
- It's a safe, autologous (from the patient's own blood) adjunct that supports tissue regeneration without added risk.

Cleft Repair & Aesthetic Procedures

In cleft palate surgeries or cosmetic soft tissue procedures, healing and scar formation are significant concerns.

How PRP helps:

- PRP supports soft tissue regeneration by delivering concentrated healing factors.
- It reduces the risk of postoperative complications like fistula formation in cleft palate repair.
- In aesthetic surgeries, PRP can modulate scar tissue—making scars less visible and improving skin texture.
- It's often injected into surgical sites to enhance healing and reduce inflammation [1-5].

Platelet-Rich Fibrin (PRF)

Platelet-Rich Fibrin (PRF) is a healing concentrate made from a patient's own blood. Unlike earlier methods like PRP (Platelet-Rich Plasma), PRF is processed without any chemicals or anticoagulants. This allows the blood to clot naturally, forming a soft, gel-like matrix rich in healing cells.

This matrix traps:

- **Platelets**-which release growth signals
- **White Blood Cells (Leukocytes)**-which fight infection and support healing
- **Stem Cells**-which help rebuild tissue

The result is a slow and steady release of growth factors over 7 to 14 days, which supports healing in a more natural and sustained way [6].

PRF Supports all three Major Phases of Tissue Repair

Inflammatory Phase

- Right after injury or surgery, platelets in PRF break open (degranulate) and release **cytokines** chemical messengers that attract immune cells.
- These messengers help control inflammation and prepare the site for healing.

Proliferative Phase

- Fibroblasts (cells that build connective tissue) and stem cells are activated.
- These cells begin forming new tissue—whether it's skin, bone, or gum.
- PRF provides a scaffold that helps these cells stay in place and work efficiently.

Remodelling Phase

- New blood vessels form (**angiogenesis**) to nourish the healing area.
- The fibrin matrix helps organize collagen and other structural proteins, restoring strength and function to the tissue [7].

PRF Variants and Their Uses

There are also specialized forms of PRF tailored for different clinical needs. Advanced PRF (A-PRF) is designed to contain more white blood cells and is often used in bone regeneration. Injectable PRF (i-PRF) remains in liquid form for a short time and is ideal for soft tissue applications and aesthetic procedures.

Titanium PRF (T-PRF), prepared in titanium tubes, offers enhanced biocompatibility and a stronger fibrin matrix, making it suitable for implantology and oral surgeries. Each variant uniquely supports healing, depending on the clinical scenario and desired outcome [7,8].

Clinical Applications in OMFS

Ridge Preservation & Alveolar Healing

After tooth extraction, the surrounding bone and gum tissue often begin to shrink or collapse. PRF, derived from the patient's own blood, contains a dense fibrin matrix rich in platelets and leukocytes. When placed into the extraction socket, PRF supports the formation of new bone and accelerates soft tissue closure. It acts as a scaffold that holds healing cells in place, stimulates angiogenesis (formation of new blood vessels), and reduces postoperative discomfort. Clinically, this translates to better preservation of ridge dimensions and faster mucosal healing, which is especially beneficial when planning for future implant placement [8].

Sinus Augmentation

In cases where the upper jaw lacks sufficient bone height for implants, sinus lift procedures are performed to create space for bone grafting. The Schneiderian membrane lining the sinus is delicate and prone to tearing during surgery. PRF helps in two key ways: first, it stabilizes the graft material by improving its cohesion and handling; second, it acts as a protective barrier over the sinus membrane, reducing the risk of perforation. Its biological activity also enhances vascularization and bone regeneration in this poorly vascularized region, leading to more predictable outcomes and reduced healing time [9].

Oroantral Fistula Closure

An oroantral fistula is an abnormal connection between the oral cavity and the maxillary sinus, often resulting from tooth extraction or trauma. If left untreated, it can lead to chronic sinus infections. PRF serves as a biologic plug that seals the communication. Its fibrin matrix supports mucosal regeneration and provides a stable environment for tissue integration. Techniques such as the double-barrier method use PRF both within the sinus and beneath a mucosal flap, promoting layered healing and minimizing the need for more invasive grafts. This approach has shown success in closing chronic fistulas with minimal postoperative complications [9,10].

Soft Tissue Grafting

In periodontal and implant surgeries, improving the quality and thickness of keratinized tissue is essential for long-term stability and aesthetics. Traditional grafts like connective tissue grafts require harvesting from the palate, which can cause significant discomfort. PRF offers a less invasive alternative. When used alone or in combination with flap techniques, PRF enhances soft tissue thickness, improves color match, and supports epithelial maturation. It reduces inflammation and donor site morbidity while maintaining comparable esthetic outcomes. This makes it a valuable adjunct in mucogingival procedures and peri-implant soft tissue augmentation [10].

MRONJ & TMJ Disorders

Medication-related osteonecrosis of the jaw (MRONJ), often linked to bisphosphonate therapy, presents with exposed necrotic bone and poor mucosal healing. PRF, when applied to the affected site, promotes angiogenesis and epithelial closure, helping to contain the necrosis and restore tissue integrity. In temporomandibular joint (TMJ) disorders, injectable PRF (i-PRF) has emerged as a minimally invasive therapy. When injected into the joint space, it supports cartilage repair, reduces inflammation, and improves joint lubrication. Patients often report reduced pain, fewer clicking episodes, and improved jaw mobility. This regenerative approach offers a promising alternative to steroids or surgical interventions [11].

Growth Factor Concentrate (GFC)

Growth Factor Concentrate (GFC) is an advanced regenerative therapy derived from a patient's own blood, designed to deliver a highly potent dose of healing molecules. Unlike traditional Platelet-Rich Plasma (PRP), which contains a mix of platelets and other blood cells, GFC is purified through specialized centrifugation and filtration techniques that isolate only the most bioactive components—specifically, growth factors. These include platelet-derived growth factor (PDGF), transforming growth factor beta (TGF-β), vascular endothelial growth factor (VEGF), insulin-like growth factor (IGF), and epidermal growth factor (EGF). These molecules play critical roles in tissue repair, collagen synthesis, angiogenesis, and cellular regeneration [12].

What sets GFC apart is its concentration: it contains roughly two to five times more growth factors than standard PRP. This makes it significantly more effective in stimulating healing responses. Additionally, GFC is free from cellular elements like red blood cells, white blood cells, and platelets. This absence reduces the risk of immune reactions and ensures a more consistent therapeutic effect across different patients and treatment sessions. Clinically, GFC is gaining traction in both surgical and aesthetic fields. In surgery, it's used to accelerate wound healing, enhance graft integration, and support bone regeneration. In aesthetic medicine, GFC is applied for skin rejuvenation, scar modulation, and hair restoration. Its ability to stimulate collagen production and improve vascular supply makes it ideal for treating fine lines, uneven skin texture, and early signs of aging. For hair loss, GFC activates dormant follicles, improves scalp health, and promotes thicker, healthier hair growth—all without the need for invasive procedures [12,13].

Clinical Applications in OMFS

Extraction Socket Healing

After a tooth is removed, the empty socket needs to heal properly to avoid pain and complications. GFC, made from the patient's own blood, contains powerful healing proteins that help the gum tissue close faster. It also reduces swelling and discomfort after surgery, making recovery smoother and quicker [13].

Cleft Palate Repair

In children born with cleft palates, surgery is done to close the gap in the roof of the mouth. GFC helps by improving bone formation in the repaired area and speeding up the healing of the soft tissue. This leads to better surgical outcomes and lowers the chances of complications like fistulas or delayed healing [13].

Sinus Lift & Implantology

When placing dental implants in the upper jaw, sometimes the bone isn't thick enough, so a sinus lift is performed to add bone. GFC strengthens the bone graft and helps it mature faster. It also improves how well the implant bonds with the bone, increasing the chances of long-term success [14,15].

Nerve Regeneration

In cases of facial nerve injury—whether from trauma or surgery—GFC plays a supportive role in healing. It protects nerve cells and helps damaged nerve fibers grow back. This can improve movement, reduce numbness, and restore facial function more effectively than traditional methods alone [15].

Aesthetic Dermatology

GFC is widely used in skin treatments like vampire facials and melasma therapy. It boosts collagen production, which helps reduce fine lines, improve skin texture, and fade dark spots. Because it's made from the patient's own blood, it's safe and natural, with minimal risk of side effects. The result is healthier, brighter, and more youthful-looking skin [16].

Expanded Applications in OMFS

- In modern OMFS practice, autologous platelet concentrates like PRP (Platelet-Rich Plasma) and PRF (Platelet-Rich Fibrin) have become valuable adjuncts across a wide spectrum of procedures due to their regenerative, anti-inflammatory, and angiogenic properties [17].
- In **sinus lift surgeries**, both PRP and PRF enhance the integration of bone grafts particularly when combined with allografts or bone marrow stem cells (BMSCs). Their presence improves vascularization and cellular recruitment, leading to more predictable bone regeneration in the maxillary sinus

region [17,18].

- For **full-mouth rehabilitation**, especially in cases involving extensive implant placement, the use of leukocyte-rich PRF (L-PRF) in combination with freeze-dried bone allografts (FDBA) has demonstrated exceptional outcomes. Clinical studies have reported up to 100% implant survival over five years, attributed to improved bone remodelling and soft tissue stability [18].
- In managing **peri-implant defects**, L-PRF glue a biologically active adhesive formed from PRF membranes has shown promise in enhancing bone-to-implant contact. It acts as both a scaffold and a healing stimulant, promoting osseointegration and reducing the risk of peri-implantitis [18,19].
- When dealing with **soft tissue complications** such as wound dehiscence or postoperative infections, PRP offers a protective and reparative effect. It's rich concentration of growth factors accelerates epithelial closure and modulates inflammation, especially in patients with compromised healing capacity [17-19].
- In **complex reconstructive procedures** like split-crest expansion, distraction osteogenesis, and block grafting, PRP and PRF support both hard and soft tissue regeneration. Their application improves graft stability, reduces healing time, and enhances the biological environment for bone formation [17-19].
- Following **tumour resection or cyst enucleation**, PRP can be used to aid in reconstructive efforts. It supports the regeneration of both bone and mucosa, helping restore anatomical contours and function while minimizing postoperative morbidity [17-19].
- For **high-risk patients**, such as those undergoing radiotherapy or taking anticoagulants, PRP has been shown to reduce healing delays. Its autologous nature and regenerative potential make it a safe and effective tool for enhancing tissue repair in compromised surgical fields [20].
- In **ENT and TMJ applications**, L-PRF has been successfully used after procedures like parotidectomy to support soft tissue healing and reduce complications. It is also employed in TMJ arthrocentesis, where its anti-inflammatory and lubricating properties help alleviate joint pain and improve mobility [20].

Conclusion

Platelet-Rich Plasma (PRP), Platelet-Rich Fibrin (PRF), and Growth Factor Concentrate (GFC) are all regenerative therapies derived from autologous blood, but they differ significantly in preparation, biological behaviour, and clinical application. PRP requires anticoagulants during processing, which allows for rapid release of growth factors once applied. It typically contains platelets and may include some leukocytes, making it versatile for a wide range of treatments, from wound healing to aesthetic procedures. PRF, on the other hand, is prepared without anticoagulants, allowing natural clot formation.

This results in a fibrin matrix that slowly releases growth factors over several days. PRF contains platelets, leukocytes, and mesenchymal stem cells, making it particularly effective for soft tissue and bone regeneration. GFC stands apart as a highly purified formulation that excludes cellular components entirely. It delivers a concentrated dose of growth factors such as PDGF, TGF-β, VEGF, IGF, and EGF, making it ideal for advanced healing and aesthetic applications, including skin rejuvenation and nerve repair.

Despite their promise, these therapies face several limitations. There is currently no universally accepted protocol for preparation or application, leading to variability in clinical outcomes. The concentration and composition of growth factors can differ significantly between patients and techniques, complicating reproducibility. Additionally, high doses of growth factors—especially in formulations like GFC—raise theoretical concerns about overstimulation of cellular pathways, including potential links to abnormal tissue growth or oncogenic activity. These risks remain under investigation, and more robust, randomized controlled trials are needed to establish long-term safety and efficacy across diverse clinical scenarios.

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