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The Revolutionary Potential of i-PRF: A Breakthrough in Implant Dentistry

Dr. Prakash Pai G[1], Dr. Dayakar M M[2], Dr. Aishwarya Krishnadas[3], Dr. Alsha Thankam George[4], Dr. Deeksha[5]

[1]Professor, Department of Periodontology, KVG Dental College and Hospital
[2]Professor & HOD, Department of Periodontology, KVG Dental College and Hospital
[3,4,5]Postgraduate Student, Department of Periodontology, KVG Dental College and Hospital

ABSTRACT:
Implant dentistry has significantly advanced over the years, offering effective solutions for patients with missing teeth. However, optimizing implant success and promoting efficient osseointegration remains a continuous focus for dental professionals. Injectable Platelet-Rich Fibrin (i-PRF) has emerged as a valuable adjunctive therapy in implant dentistry, aiming to enhance the regenerative potential of tissues and improve clinical outcomes.
I-PRF is an autologous blood concentrate derived from the patient's own blood, rich in platelets, leukocytes, growth factors, and fibrin matrix. This biological material offers numerous benefits in implant dentistry, including its ability to accelerate wound healing, enhance soft tissue regeneration, and stimulate bone formation. I-PRF is obtained through a simple and chairside centrifugation process, making it readily accessible and cost-effective.
In conclusion, i-PRF represents a valuable adjunctive therapy in implant dentistry, providing clinicians with a natural and effective means to optimize implant success and promote tissue regeneration. As research continues to expand in this field, further investigations are needed to explore the full potential and standardize the protocols for i-PRF application, ensuring its widespread utilization and integration into routine implant procedures.

Keywords: Implant, Injectable Platelet-Rich Fibrin (i-PRF), Osseointegration , Regenerative.

INTRODUCTION

Implant dentistry has transformed the field of dental restoration, offering patients a reliable and long-lasting solution to replace missing teeth. The success of dental implants depends on various factors, including bone quality, surgical techniques, and post-operative care. In recent years, a breakthrough in regenerative medicine called Injectable Platelet-Rich Fibrin (i-PRF) has emerged as a powerful tool in implant dentistry. This article explores the role of i-PRF in implant dentistry. The application of i-PRF in implant dentistry involves various techniques [1].
Prior to implant placement , i-PRF can be applied topically to the surgical site or mixed with bone grafting materials to improve their handling characteristics and biological properties. Additionally, i-PRF can be injected directly into the peri-implant tissues, promoting vascularization, reducing inflammation, and accelerating tissue integration.

Clinical studies have demonstrated the positive effects of i-PRF in implant dentistry. The use of i-PRF has been associated with reduced postoperative discomfort, improved soft tissue healing, and enhanced implant stability. Moreover, i-PRF has shown promising results in challenging clinical situations such as immediate implant placement and immediate loading protocols.The regenerative properties of i-PRF can be attributed to the release of growth factors and cytokines, which play a vital role in angiogenesis, cell proliferation, and extracellular matrix formation. By harnessing the patient's own healing potential, i-PRF offers a biocompatible and safe alternative to synthetic growth factors or allogenic materials [2].

UNDERSTANDING I-PRF

Injectable Platelet-Rich Fibrin (i-PRF) is an advanced form of platelet-rich fibrin (PRF) that has gained popularity in dentistry. PRF is an autologous substance derived from the patient's blood, containing a high concentration of platelets, growth factors, and cytokines. The i-PRF is created by centrifuging the patient's blood, which separates it into different layers, including a fibrin clot rich in platelets and growth factors. I-PRF, short for injectable platelet-rich fibrin, is an advanced form of PRF that takes the benefits of traditional PRF to the next level. PRF itself is derived from a patient's blood, containing platelets, growth factors, and other bioactive molecules. These components play a crucial role in tissue repair and regeneration.

I-PRF, however, goes beyond the limitations of conventional PRF preparations by offering a liquid form that can be easily injected into specific areas of the body. Fibronectin, an extracellular glycoprotein, is the main component of injectable platelet-rich fibrin. Fibronectin has a big molecular weight. Additionally, applying fibronectin to the surfaces of roots promotes cellular growth. From supra-crestal components to periodontal ligaments, cellular growth spreads. Last but not least, I-PRF offers higher biologic qualities than PRP [3] .

Unlike traditional PRF, which is a gel-like substance, i-PRF can be injected using a fine needle, allowing for targeted delivery to affected tissues or areas requiring regeneration. This injectable form opens up a wide range of possibilities for i-PRF application, making it highly adaptable to various medical specialties, including dentistry, orthopedics, dermatology, and more.

OSSEOINTEGRATION IN IMPLANTS

The initial phase in a dental implant's stability and long-term survival is successful osseointegration[4]. The need for quicker treatment times has increased along with advancements in the field of oral implantology. The length of time between implant insertion and prosthesis delivery is significantly influenced by the rate of osseointegration. The goal of surface changes made by implant manufacturer's is to enhance bone-implant contact (BIC) and shorten the period needed for full osseointegration before the implant may be loaded [5]. Numerous inflammatory mediators and growth factors regulate the entire osseointegration cascade, which is a complicated process [6]. Therefore, the use of autologous blood derivatives that have a high concentration of growth factors and bone-specific proteins might be viewed as another method for enhancing the BIC and decreasing osseointegration time.

For more than 30 years, platelet concentrations have been used in dentistry. They have the capacity to release large amounts of growth factors that trigger tissue regeneration. PRP was among the first iterations of these autologous concentrates, but it fell out of favour because of worries about the use of anticoagulants in its preparation . The second generation of PRF is produced devoid of anticoagulants . The capacity of autologous blood derivatives to promote increased fibroblast migration and the

production of PDGF, TGF-, and collagen 1 as well as release larger amounts of a variety of growth factors was established [7] . The development of a fibrin clot, which acts as a three-dimensional scaffold for tissue regeneration, is a crucial component. Within minutes of blood collection, PRF produces a fibrin clot because it lacks anticoagulants [8]. Anticoagulants were not utilised in the development of the injectable PRF (i-PRF) formulation. It must be used within 15 minutes since it is produced by centrifugation at lower rates (700 rpm) for only 3 minutes before the creation of a fibrin clot. Human gingival fibroblast cell migration, proliferation, and distribution are all markedly increased by i-PRF[9]. Faster tissue angiogenesis promotes quicker wound healing, which is another benefit .

Surface alterations are marketed by implant producers as a way to improve BIC and speed up osseointegration, however these improvements also sharply raise the price of each implant. The use of i-PRF as a surface coating carried out as a chairside technique to cover the surface of the implant right before insertion might be adopted to increase osseointegration in addition to surface changes offered by the manufacturer. It could be a straightforward, affordable, and efficient technique to guarantee improved implant success and shorter treatment times. Due to its liquid nature, it can be applied uniformly over the implant surface.

PROPERTIES OF I-PRF

Platelet-derived growth factor (PDGF) like PDGF-AA and PDGF-AB, as well as greater growth factor release, have been seen in i-PRF at the end of ten days.

Comparing PRP to insulin-like growth factor-1 (IGF-1) and epidermal growth factor (EGF),

2. PRP and i-PRF showed comparable tissue compatibility.

3. Higher cellular migration was seen with i-PRF.

4. At 7 days, transforming growth factor (TGF-) and collagen-1 m-RNA expression in cell culture was dramatically increased by i-PRF. This preliminary evidence suggests that when compared to PRP, i-PRF may have comparable or somewhat greater biologic qualities.

5. Fibronectin, a glycoprotein found outside of cells with a large molecular weight (about 440 kDa), is what is known as i-PRF. The periodontal ligament and supracrestal cells proliferate better when fibronectin is applied to the root surfaces.

6. The increased concentration of platelets and other blood cells such leukocytes in I-PRF compared to other platelet concentrates may be the only cause of the enhanced antibacterial activity with I-PRF in the case of Pg. This can be explained by Ghanaati et al.'s [10] idea of "low-speed" for blood centrifugation. He found that cells containing leukocytes are more prevalent in low centrifugation speed samples before fibrin clot formation.

7.The bone graft and i-PRF have the ability to bind, allowing proper adaptation of defect area [11].

ADVANTAGES OF I-PRF

One of the many benefits of PRF is that it is 100 percent autologous.

1. It comes in injectable form.

2. Can be utilised alone or in combination with different biomaterials.

3. The ability to produce a large number of regenerative cells as more growth factors are released. 4. Created a tiny fibrin clot that served as a dynamic gel.

5. Plays an additive effect in the release of growth factors for roughly 10 days.

6. It reduces the likelihood of a negative response. [11] .

DISADVANTAGES OF I-PRF

Because platelet-rich plasma is produced without the need of extra anticoagulants, the main clinical benefit of I-PRF is based on the short handling time between blood collection and centrifugation. Because it contains circulating immune cells and highly antigenic plasmatic compounds, the fibrin matrix can only be used for that specific donor, which is a severe downside. I-PRF that has been stored could also get infected with bacteria if it is not utilised straight away [3].

PREPARATION PROTOCOL OF i–PRF

1. In line with Mourao et al. Collect 9 ml of unpreservatived autologous blood in a test tube. After that, it was centrifuged for 2 minutes at 3300 rpm, forming the orange-colored fluid into the tube known as I-PRF [12].
2. In line with Miron RJ et al. Without using any additional anticoagulants, collect autologous blood in disposable tubes. After that, it was centrifuged at 700 rpm for 3 minutes. Plastic tubes' hydrophobic surface prevents the coagulation process from being efficiently activated. Thus, all of the blood's clotting components and platelets necessary for the creation of platelet concentrate arrive in the tube's top zone during the first two to four minutes of centrifugation. Together, these seperated platelets and plasma together are located at the upper layer in light yellow color used in injectable form [7].
3. In accordance with Al-Maawi et al. According to the low-speed centrifugation idea, the test tube containing the collected blood was immediately maintained in the centrifuge at 600 rpm, 44 g for 8 minutes. After centrifugation, i-PRF was created, consisting of various blood components in the bottom zone and yellow-orange coloured components in the top zone [13].
4. Castro et al. 2019, Cortellini et al. 2018, updated the injectable PRF original technique. Test tubes with collected blood inside were spun in a centrifuge for 2,700 rpm for 3 minutes and 408 grams [14,15].
5. According to Miron et al. 2019, the i-PRF was prepared using a horizontal centrifugation process at 200g for 8 min. Leukocyte and platelet concentrations are increased as a result, reaching 10.92 109 cells/L (178% original values) [16].

I-PRF IN IMPLANT DENTISTRY

1. Enhanced Bone Regeneration: One of the primary benefits of i-PRF in implant dentistry is its ability to promote bone regeneration. The growth factors and cytokines present in i-PRF stimulate the recruitment and proliferation of osteoblasts, the cells responsible for bone formation. By applying i-PRF to the implant site, it accelerates the healing process and improves bone density, leading to better implant stability [2].

2. Improved Implant Success Rate: The success of dental implants relies on the integration of the implant with the surrounding bone. i-PRF facilitates this process by providing a favorable environment for osseointegration. The growth factors present in i-PRF enhance the formation of new blood vessels, promote cellular migration, and stimulate the production of extracellular matrix components. These mechanisms contribute to a higher success rate of dental implants, reducing the risk of implant failure.
3. Faster Healing and Reduced Inflammation: i-PRF plays a crucial role in the post-operative phase of dental implant placement. When applied to the surgical site, i-PRF helps accelerate wound healing and

reduces inflammation. The growth factors present in i-PRF modulate the immune response, leading to a faster resolution of post-operative swelling and pain. The use of i-PRF in implantology has been associated with a reduced risk of postoperative complications, such as infection and inflammation. The antimicrobial properties of i-PRF, along with its ability to modulate the immune response, can help minimize the chances of infection and promote a more favorable healing environment. Additionally, i-PRF provides a protective barrier, preventing the exposure of the implant surface to the oral cavity, thus minimizing the risk of infection [7].

4. Preservation of Soft Tissue: Along with promoting bone regeneration, i-PRF also aids in the preservation of soft tissue surrounding dental implants. The growth factors present in i-PRF stimulate angiogenesis, the formation of new blood vessels, which ensures an adequate blood supply to the surrounding soft tissues. This process promotes tissue healing, reduces the risk of gum recession, and enhances the esthetic outcome of implant restorations.

5. Simplicity and Convenience: The injectable nature of i-PRF makes it a convenient option during implant surgery. It can be easily applied at the surgical site, either as an adjunct to bone grafting procedures or as a stand-alone treatment. The simplified procedure saves time and reduces patient discomfort.

I-PRF has the potential to release vital growth factors including PDGF and TGF, which are in charge of bone remodelling, as well as a fibrin scaffold. A study was conducted in the Department of Oral Implantology, Saveetha Dental College and Hospital, Chennai from September 2020 to February 2021 to determine if covering the implant with injectable platelet-rich fibrin (i-PRF) prior to implantation would speed up osseointegration. The study was conducted in a population of age between 18 and 60 years, with the absence of both posterior mandibular teeth, and the availability of sufficient bone for conventional implants were the inclusion criteria for patients. 10 patients made up the whole sample. Two groups were used in this split-mouth trial: Group A (test), which included locations where Straumann SLA (Sandblasted Large grit Acid-etched) implants coated with i-PRF were placed, and Group B (controls), which comprised sites where Straumann SLActive implants were inserted [17].
On the day of placement and at the one-week and six-week follow-ups, ISQ (Implant Stability Quotient) values were recorded using RFA smart pegs. To determine if there was a significant difference between the two groups, statistical analysis was done using the Wilcoxon Sign Rank Test.According to the findings of this pilot study, there was no discernible difference between the two groups.
This shows that the coated implants the coated implants were able to match the faster osseointegration time of the active implants. The findings of this study demonstrate the potential of applying i-PRF to the surface of implants to increase stability and promote osseointegration more quickly [17].

DV-PIMS TECHNIQUE

The innovative implant design that disperses an i-PRF solution from the inside out is explained by this (DV-PIMS) approach. The new implant's screw portion is constructed of an internal reservoir that runs vertically downward. After adding (injectable) PRF to the reservoir, a cover screw is placed. As the solution progressively diffuses out through the implant's vents, biofilms are prevented from accumulating there and the healing process is hastened [18].

SINUS LIFTING AND DENTAL IMPLANT PLACEMENT

Placement of dental implants and sinus lifting numerous research have concentrated on improving the stability and durability of dental implants since they are a frequently utilised treatment method for restoring oral function and aesthetics. Assessing appropriate bone support, which is evident in the posterior of the maxilla, is crucial for the stability of dental implants [19]. In certain patients, the maxillary sinus near the back of the maxilla might lessen the amount of bone support needed for implant placement. In order to enhance the bone height in the posterior portion of the maxilla and allow for the insertion of implant-supported prostheses, maxillary sinus lifting surgery is required [19].

In order to encourage vertical bone augmentation into the maxillary sinus cavity, this treatment entails separating the Schneiderian membrane from the maxillary sinus floor and producing a gap that is filled with a grafting biomaterial [19,20]. As a result, several osteoinductive and osteoconductive biomaterials have been applied to the maxillary floor to promote bone rebuilding. The use of IPRF in sinus augmentation can potentially improve the healing of the bone graft material placed in the sinus and promote new bone formation. It helps stimulate tissue regeneration, reduce inflammation, and enhance the integration of the dental implant with the surrounding bone. By utilizing the patient's own blood components, IPRF is considered a safe and biocompatible option for enhancing the outcomes of sinus augmentation procedures.

In this study by Mu et al. [21] they aim to assess the angiogenic and osteogenic capacity in rabbit sinus model grafted with Deproteinized bovine bone mineral (DBBM) particles soaked in injectable Platelet rich fibrin (iPRF), both of which interacted to form an integrated block .I-PRF has been evaluated for elevation of the maxillary sinus floor as a promising material in bone regeneration. The combination of demineralized bovine bone mineral (DBBM) with and without I-PRF was applied bilaterally in the maxillary sinuses of 16 rabbits by Mu et al. [21] in this respect. The I-PRF-DBBM group had an increased rate of bone formation at the second and fourth weeks, but there was no difference in the ultimate amount of new bone at the 7th week.

I-PRF (Injectable Platelet-Rich Fibrin) can also be used in cases of failing dental implants as a potential treatment modality to improve the outcome and potentially salvage the implant. When an implant fails, it may be due to factors such as peri-implantitis (inflammation and infection around the implant), inadequate osseointegration (lack of integration with the surrounding bone), or mechanical complications. It's important to note that the success of using I-PRF in failing implants depends on various factors, including the specific cause of the implant failure, the extent of tissue damage, and the overall condition of the patient. Not all failing implants can be saved, and in some cases, alternative treatment options such as implant removal and replacement may be necessary. A thorough evaluation by a qualified dental professional is crucial to determine the most appropriate course of action and whether I-PRF can be beneficial in a specific case.

FUTURE IMPLICATIONS

I-PRF's introduction into regenerative medicine opens up a realm of possibilities for non-surgical, minimally invasive treatments. Its potential for tissue repair, accelerated healing, and regeneration makes it an attractive option for both patients and healthcare professionals. As research and clinical trials continue, we can expect to see further advancements in I-PRF technology, expanding its applications and revolutionizing the way we approach various medical conditions.

CONCLUSION

Injectable Platelet-Rich Fibrin (i-PRF) has revolutionized the field of implant dentistry by offering numerous advantages in terms of bone regeneration, implant success rates, healing speed, reduced inflammation, and preservation of soft tissue. Its regenerative properties make it an invaluable adjunct to conventional dental implant procedures, enhancing patient outcomes and satisfaction. As research and technological advancements continue, i-PRF is expected to play an increasingly significant role in the future of implant dentistry, providing even better treatment options for patients seeking dental implant solutions [22,23]

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