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Plateletrichplasma (PRP) in Orthodontics - Current Trends

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Abstract: ***Submucosal injection of platelet - rich protein is a technique for speeding orthodontic tooth movement by imitating the impact of bone without causing alveolar bone loss or necessitating a surgical procedure. With a growing awareness of orthodontic treatment among people of various ages, the focus has shifted to improving the rate of tooth movement. The current ways of increasing tooth movement, as well as the role of platelet rich plasma, are discussed in this article. The use of platelet rich plasma and its effects on orthodontic tooth movement are also briefly described.***

Keywords: PRP, Tooth movement, orthodontics

1. Introduction

Orthodontic tooth movement is the result of a biological response to an externally applied force disrupting the dentofacial complex's physiological equilibrium[1]. The rate of orthodontic tooth movement has been amplified using a variety of methods. Despite the fact that each technique has been claimed to be superior to the others in various studies, there is still conflicting evidence regarding each technique[2, 3]. Many of these techniques rely on the regional acceleratory phenomenon (frost 1983), which is built on the concept that when the bone is surgically injured, an inflammation cascade is triggered, resulting in greater osteoclastogenesis and hence rapid tooth movement.

The majority of procedures cause damage to the bone tissue. This has shifted the focus from invasive to less invasive techniques, resulting to more study in the fields of ultrasonic vibrations, photobiomodulation, low - level laser therapy, and pharmacological approaches to accelerate orthodontic tooth movement. Since the 1980s, pharmacologic techniques to accelerates orthodontic tooth movement have been studied in individuals. Pharmacologic methods, if clinically effective, may surpass other approaches since they are less invasive, less expensive, and more regulated. The issue that remains is the possibility of concurrent adverse effects, especially when systemic injection is used[4].

Vibration or photobiomodulation are two of the most recent noninvasive technologies that could be the most realistic and practical strategies for speeding up orthodontic tooth movement, but further experimental and clinical investigations are needed to confirm their clinical usefulness[5, 6]. Despite the fact that all of the aforementioned tactics have been demonstrated to be beneficial, the degree of effectiveness varies greatly. Non - surgical treatments or less invasive procedures like micro - osteoperforations or piezopuncture have been much less effective than invasive techniques involving more bone removal, such as traditional corticotomy[7].

As a result, biochemical adjuncts may be used to provide an equally effective biological response from the minimally invasive procedure. This is accomplished by the employment of cytokines like prostaglandin and hormones like relaxin. Supplemental hormones or other allogenic products, on the other hand, can have unfavourable systemic effects. Robert Marx was the first to use PRP in dentistry. PRP is a volume of autologous plasma with a platelet concentration that is higher than normal[8]. PRP injections speed up orthodontic tooth movement by lowering alveolar bone density due to enhanced osteoclast activity. This review article discussed about composition, preparation, mechanism, side effects and effects of PRP on orthodontic tooth movement.

Platelet - Rich Plasma (PRP)

Platelet - rich plasma (PRP) is a short volume of plasma containing an autologous concentration of human platelets. Platelet concentration and the seven - fundamental growth factors, which are actively released by platelets to promote wound healing, are also included. Platelets are one of the promoters of wound healing in both soft and hard tissue. Growth factors found in platelets include platelet - derived growth factor, transforming growth factor, endothelial growth factor, and others. This growth factor are vital in the regulation and promotion of wound healing, as well as in the regulation of cellular processes such mitogenesis, chemotaxis, differentiation, and metabolism[9]. The 94 percent of red blood cells (RBCs), 6% of platelets, and 1% of white blood cells (WBCs) are found in peripheral blood, while PRP comprises 5% of RBCs, 1% of WBCs, and 94 percent of platelets. PRP has been used in dentistry to improve osseointegration of dental implants and enhance alveolar bone height in maxillary sinus lift procedures[10 - 12].

PRP preparation and its process

This method produces PRP that is only transient. It's made by combining extracted PRP with 10 mL of 10% calcium chloride and 10000 units of bovine thrombin in a 10 mL tube. Each mix contains 6 ml of PRP, 1 ml of calcium chloride and thrombin mix, and 1 ml of air to act as a mixing

bubble while stirring to produce a clot in a 10ml syringe. PRP should be injectable and long - lasting for usage in orthodontics. Avoid mixing with calcium chloride or thrombin if you want a PRP with a long - lasting impact. As a result, it maintains its liquid condition and is injectable.

Three 30 ml syringes, each containing 3 ml of 10% sodium citrate solution as an anticoagulant, were used to collect 60 ml of whole blood from a patient's medial cubital vein. Due to its systemic effects and induction of alveolar bone resorption, heparin is not advised for use as an anticoagulant. The platelet counts are checked using one millilitre of blood.

The remaining 59 ml of whole blood is centrifuged at room temperature for 12 minutes at 1000 rpm. RBCs are separated at the bottom, buffy coat (platelets) in the centre, and platelet deficient plasma (PPP) at the top of the blood.

The PRP in this preparation contains anticoagulant, a high concentration of platelets, and a few RBCs and WBCs, and it must be injected quickly after being prepared. According to the methodology published by Choukroun et al. in 2001, samples were immediately table - top centrifuged at 3000 rpm for 10 minutes[13]. The RBCs are discarded, and the buffy coat and PPP are collected and centrifuged for another 8 minutes at 3000 rpm. The PPP is withdrawn until 4 ml remains after the second centrifugation, and the remaining PPP is combined with the buffy coat to form PRP. The platelet count of one millilitre of PRP is determined.

Composition of PRP

There are seven fundamental growth factors present in the prp out of which[14]

- 3 - are isomeres of platelet derived factors [PDGFαα, PDGFββ, PDGFαβ]
- 2 - transforming growth factors [TGFβ1 and TGFβ2]
- Vascular endothelial growth factor
- Epithelial growth factors
- They also contain 3 proteins which acts as cell adhesion molecules forosteoconductionand matrix for bone, connective tissue and epithelial migration. The cell adhesion molecules present arefibrin, fibronectin, vitronectin.

2. Mechanism

The degranulation of cellular alpha - granules, which contain growth factors and cytokines, is the source of PRP's effect. These biochemical messengers are produced during the clotting process, which is also known as coagulation. It starts with the release of growth factors within the first hour of the clotting process, and the majority of the messengers are produced within 1 - 2 hours. As a result, PRP must be made in an anticoagulated state and used within 10 minutes of the clot beginning. In a sterile environment, PRP in the anticoagulated state can last up to 8 hours. The growth factors in the platelet granules are inactive until the clotting mechanism comes in and makes them soluble. Especially in the initial burst of PRP - GFs, platelets continue to synthesise and secrete more GFs for the remainder of their 5 - 7 - day lifespan. Following that, inflammatory macrophages continue to promote healing by secreting growth factors that are identical to those seen in the body. As a result, the rate of wound healing is determined by the amount of platelets in the blood clot within the graft, wound, or adhered to a flap. PRP, as a rich source of platelets, is used as a supplement throughout the physiological healing process and delivers a higher concentration of GF. This increases cellular activity and speeds up the healing process.

Autologous sources are also necessary for the success of the PRP, and pre - synthesised homologous sources should be avoided. This guarantees HLA compatibility at the application site.

Factors that affect the effectiveness of PRP

- Concentration of the platelets
- Cellular composition of PRP
- Balance between anabolic and catabolic activities (Pro and anti - inflammatory cellular activity)
- Promotes production of RANTES (regulated on activation, normal t - cell expressed and secreted),
- Blocks MCP - 1 (monocyte chemotactic protein) release from monocytes,
- Increases the concentration of LXA4, suggesting that PRP facilitates healing by controlling the local inflammatory response.
- According to Hesham et al, PRP acts as an anti - inflammatory by modulating monocytic secretory activity directly.1[5]

Submucosal injection of platelet rich plasma for orthodontic purposes

The PRP is injected submucosally, along with the anticoagulant it contains. Because of the anticoagulant, we hypothesised that following PRP injection, only a portion of the platelets attach and aggregate on the surfaces of collagen fibres, and the intrinsic and extrinsic pathways of hemostasis begin to produce thrombin. Platelet clots eventually form above the periosteum, and subsequently growth factors release and penetrate the periosteum and alveolar bone. For pain control, local anaesthetic (Xylocaine) should be given at the target locations before to the injection of PRP.0.7 cc of PRP could be injected into each target site. To avoid PRP leaking, inject the PRP through the connected gingivae into the oral mucosa with a 27 - gauge dental needle.

For post - injection pain relief, acetaminophen (500 mg) could be recommended. Nonsteroidal anti - inflammatory drugs (NSAIDs) will counteract the effects of PRP and are not recommended for post - injection pain relief. Eighty - five percent of patients experienced acceptable postinjection discomfort for 6–12 hours, including intraoral mucosal swelling, itching, and mild to moderate pain, although 15% of patients experienced severe pain. The severity of post - injection discomfort varies depending on the PRP concentration. Clinical trials have shown that the higher the PRP content, the greater the postinjection discomfort.

3. Application of PRP in Orthodontics

1) PRP and Tooth Movement

The progressive remodelling of supporing alveolar bone causes orthodonic tooth movement. The process of bone

remodelling involves osteoclasts resorbing existing bone and osteoblasts forming new bone[16]. The bone remodelling process can also be influenced by mechanical loads, namely orthodonic forces. The quality and quantity of orthodonic tooth movement is determined by the alveolar bone turnover rate. The equilibrium between resorpion and apposiion must be changed to move teeth faster and minimiseorthodonic therapy time. According to Aysegul et al, orthodontic tooth movement is aided by localized osteoclastic activity when moderate and high platelet concentrations are injected. At 3, 7, 14, and 21 days, the experimental group's alveolar bone density was lower than the control group's. At the end of the 21 - day period, the hPRP - E group had 1.7 times faster orthodontic tooth movement than the control group and 1.4 times faster orthodontic tooth movement than the mPRP - E group[17].

Rashid et al mentioned the effects of various PRP concentrations on alveolar bone density and orthodonic tooth movement were investigated. Sixty - six rats were separated into two groups: one with a moderate concentration of PRP injecion and another with a high concentration of PRP injecion. Three, seven, fourteen, twenty - one, and sixty days were studied in each group. Moderate and high concentrations of PRP were injected on the right sides of the molar buccal sulcus before orthodonicmesialization of the maxillary first molar, with the left sides serving as controls. Three - dimensional digital models were used to measure tooth motions. In the first molar intraradicular zones, alveolar bone volume density and osteoclastic activity were measured by histometric analysis. At 3, 7, 14, and 21 days, the results demonstrated that the experimental groups' alveolar bone density was lower than the control groups. On day 3, the experimental groups' osteoclastic activity was higher than the controls'. On day 21, the high - concentration experimental group had 1.7 times more tooth movement than the high - concentration control group and 1.4 times more tooth movement than the moderate - concentration experimental group. On day 60, all groups' alveolar bone density had returned to their normal levels[18]. According to Ahmed. El. Timamal, the rate of canine retraction increased by 15% on the intervention side and by 5% on the second month. The rate of canine retraction on the intervention side was 40% slower than the control side during the termination of PRP injection. The injection of PRP and quick orthodontic tooth movement were found to have a good association[19].

2) PRP and alveolar bone grating in cleft patients

The efficacy of PRP for secondary alveolar bone graft surgeries was evaluated in 20 patients with cleft lip and palate. Twenty patients aged 8 to 30 were randomly assigned to undergo cancellous bone grafts from the anterior iliac crest mixed with PRP, whereas the control group had the same procedure without PRP. There were no statistically significant differences in primary healing rates, and although pain and edema lasted longer in the control group, this was also not statistically significant. PRP - infused bone grafts, on the other hand, showed considerably higher bone density six months after surgery (1028.00 +/ - 11.30 HU versus 859.50 +/ - 27.73 HU) [20].

Sakio R et al [21] employed simple ilm radiography to assess bone changes; however, this study used computed tomography. The authors recognise that their study had a small sample size, with just 23 patients having autologous iliac cancellous bone and marrow grafts with PRP and only 6 patients receiving the same procedure without PRP. All of the participants were between the ages of 7 and 8, and they were not assigned at random. The mean remaining bone was not significantly different between those treated with PRP and those who were not at 1 year post - surgery, according to the quantitative analysis of the grat sites. **Reiko sakioet al**[22] concluded that there was no evidence to suggest that autologous PRP is of value for effect on the bone resorption for alveolar bone graft. **Tomoki oyamaet al**[23] Use of PRP was a good source of growth factors and easy to extract it enhacesosteogenesis of alveolar bone grafting in cleft patients. The volume of regenerated bone in alveolar cleft with PRP was higher than in controls.

3) PRP and periodontally accelerated osteogenic orthodontics

Using Leukocyte and Platelet - Rich Fibrin (L - PRF) in PAOO, researchers investigated post - operative discomfort, inflammation, infection, and post - orthodontic stability. Eleven patients who needed orthodontic treatment and were periodontally appropriate were evaluated immediately after surgery and again two years later **by** Muñoz F et al[24].

A faster wound healing rate was noted, with no symptoms of infection or adverse responses, and post - surgical pain was reported as mild to moderate. All patients had complete resolution by day 8, and the active orthodontic treatment time was reported to be 9.3 months. For the next two years, all of the cases were judged stable. While these findings are encouraging, the study's limited sample size and lack of a control group will necessitate more research in this area.

4) PRP on alveolar ridge preservation

The use of occlusive membranes to cover the extraction socket entry, according to Kim et al, is a strategy for minimising alveolar ridge resorption and increasing bone growth. Absorbable gelatin spongy or gelatin spongy soaked in platelet rich plasma (PRP) improved wound healing, preserved the extraction socket, and stimulated bone growth after extraction.

Clinical Applications for Platelet Rich Plasma Submucosal Injection

1) The injection of PRP could be applied for accelerating orthodontic tooth alignment and leveling in anterior crowding and space closure in *en masse* anterior retraction or molar protraction. It could also be used for preserving the pressure side alveolar bone of *en masse* anterior retraction.
2) The target sites of injection are the labial and lingual/palatal sides of the anterior teeth when the purpose of injection is to accelerate the alignment and leveling.
3) The target site is the lingual/palatal side of anterior teeth when the purpose is to accelerate anterior retraction or to preserve the pressure side alveolar bone.
4) The target sites could be the buccal, lingual/palatal, and mesial sides of the posterior teeth when the purpose is to

accelerate the protraction of posterior teeth or preserve the alveolar bone of the protracted posterior teeth.

Dosage

Clinically, a single PRP injection lasts 5–6 months. The fastest rate of acceleration has been noticed clinically during the second to fourth month following the injection. The following is a summary of the various regimens used for various purposes:

- A single PRP injection is given at the start of treatment to help with alignment and levelling.
- For the objective of anterior retraction, one PRP injection was given at the start, followed by a booster injection six months later.
- For the objective of posterior tooth protraction, one PRP injection was given at the start, followed by another injection six months later.

4. Adverse Effects

Acceptable discomfort like mucosal swelling, irritation, itching sensation and mild to moderate pain was experienced by eighty five percentage of people after 6 - 12 hours post injection.

A study shows that 15% of patients experienced severe pain, the intensity of post injection discomfort increased with the increase in concentration of the injected PRP

5. Conclusion

The use of PRP and PRF is becoming more common in a wide range of medical and dental professions. While its applicability in areas like implant dentistry and oral surgery may seem obvious, we are just now seeing the publishing of a few studies in orthodontics. Through a variety of processes, PRP has the potential to enhance periodontal regeneration. The effect of PRP on localised tooth movement acceleration is proportional to the concentration employed. The process of synthesis, on the other hand, is important to the effectiveness of PRP - based tooth movement acceleration. By affecting bone quality and increasing the rate of tooth movement, the use of injectable PRP at various stages of orthodontic therapy can improve the quality of the treatment outcome.

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