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Effect of Platelet-rich Plasma on Implant Stability in the Mandible

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Abstract

Background and aims. Plasma rich in growth factors (PRGFs) has been recently proposed as an aid to enhance regeneration of osseous and epithelial tissues in oral surgery. The purpose of this study was to determine the effect of local application of platelet-rich plasma (PRP) on implant stability measured by periotest.

Materials and methods. A total of 24 implants were placed in the mandibles of 12 lower edentulous patients. In each patient, 2 implants were placed anterior to the mental foramen in bilateral canine sites. One implant in each patient was dipped in autogenous PRP before insertion (test group), while the other implant was not embedded in PRP (control group). Repeated stability measurements were carried out by periotest on the day of surgery and 1, 2, 4 and 8 weeks after surgery.

Results. In both groups minimum periotest values (highest stability) were observed on the day of surgery and 8 weeks after surgery. The maximum periotest values (lowest stability) were observed in 4th week after surgery. Considering implant stability, no statistically significant differences were observed between the test and control groups at any time ($P>0.05$). In the PRP group, the difference in implant stability between the day of surgery and the 2nd and 4th weeks were statistically significant ($P<0.05$).

Conclusion. Application of PRP on implant surface did not have any additional effect on implant stability in the mandible.

Key words: **Implant stability, osseointegration, periotest, platelet-rich plasma.**

Introduction

Oral rehabilitation with implant-supported prostheses is a well-documented therapy that is viewed as a routine procedure. This breakthrough in oral rehabilitation was initiated by the discovery that dental implants, made of commercially pure titanium, can achieve anchorage in the jaw bone with direct bone-to-implant contact. This functional anky-

losis is often referred to as osseointegration and was first described by two research groups of Brånemark and Schroeder.[1] In the past decades, implant dentistry has undergone a series of advances that allowed for modification of the original protocol. The original Brånemark protocol requires the implant to be inserted 4-6 months prior to loading. This long treatment period that involves the wearing of a temporary prosthesis may be of great inconvenience, and is sometimes the reason for not choosing implant-supported restorations at all. But, it is now well documented that immediate and early loading protocols have shown success rates similar to the conventional delayed loading.[2,3] However, an important factor for immediate loading and success of implant procedure is good initial stability.[4] Obviously, any factor which could accelerate or promote the osseous regeneration will be beneficial for initial healing around dental implants. Plasma rich in growth factors (PRGF) has been recently proposed as an aid to enhance regeneration of osseous and epithelial tissues in oral surgery.[5] Several in vitro studies, animal experiments and clinical studies have shown that platelet-derived growth factors can possibly trigger stimulation of osseous and soft tissue regeneration, as well as reduce inflammation, pain and unwanted side effects.[6-13] The biologic properties of PRGF exploit the potential of several autologous platelet-derived growth factors (platelet-derived growth factor, transforming growth factor, endothelial growth factor, vascular endothelial growth factor, insulin-like growth factor-1, basic fibroblast growth factor, hepatocyte growth factor), obtained with a simple centrifugation procedure. These growth factors may specifically stimulate several biologic functions such as chemotaxis, angiogenesis, proliferation, differentiation and modulation, thereby representing an effective therapeutic device for more rapid and effective regeneration of hard and soft tissues.[14-16] The aim of this research was to assess the effects of PRP on the stability of implants (measured by periotest) placed in the anterior edentulous mandible.

Materials and Methods

This was a randomised single-blind split-mouth controlled clinical trial. The study was performed within the guidelines of the World Medical Association Helsinki Declaration of 1975 for biomedical research involving human subjects, as revised in 2000.[17]

Twelve completely edentulous patients, referred to the Department of Periodontics and Prosthodontics of Islamic Azad University, Isfahan (Khorasgan Branch) for insertion of 2 implants for overdenturs in lower anterior region (from Sep 20012 to June 2013), were recruited. The inclusion criteria consisted of complete lower edentulous patients, the presence of adequate quality and quantity of native bone with minimum of 13 mm available bone height and 6 mm of width for insertion of two #4.1/11 implants in the lower anterior region and no general medical contraindications for oral surgical procedures. All the patients included in the present study provided written informed consent. The exclusion criteria consisted of any disease, condition or medication that might compromise healing or osseointegration, uncontrolled diabetes, smoking >10 cigarettes per day and an inability or unwillingness to return for follow-up visits.

Collection of Blood and Preparation of PRGF Concentrate

Before surgery and before the administration of local anesthesia, 5–20 mL of blood was drawn from the median cubidal vein. The blood was deposited in 5-mL laboratory glass tubes pretreated with 3.8% trisodium citrate. The tubes were centrifuged at 270 *g*, at room temperature for 7 minutes in a centrifuge unit specifically designed for use with this technique (PRGF System; BTI Biotechnology Institute, Vitoria, Alava, Spain). After centrifugation, the blood was separated into distinct layers, with the cellular components (mostly red blood cells and a thin layer of white blood cells) remaining at the bottom of the tube, and the plasmatic component above.[18] The inferior half of the latter was collected and stored in a sterile glass container until use. The total preparation time for this technique was approximately 10–15 minutes.

About 50 uL of 10% $CaCl_2$ were added to 1 cm^3 of PRGF concentrate to enable clot formation. Although stable clots will develop within 5 to 8 minutes at room temperature, maintenance of the preparation at 37°C enabled this period to decrease to about 3 minutes.

Surgical Procedure

After anaesthetizing the area with 2% lidocaine with 1:100,000 adrenaline, full-thickness mucosal flaps were raised to completely expose the buccal and lingual cortices of the bone in lower anterior region. 10-12 mm on either side of the lower midline, an osteotomy site was prepared for insertion of Allfit SSO 4.1/11 mm implants (Dr Ihde Company, Germany). Tossing a coin, on one side before placement, the implants were embedded carefully in liquid PRGF for 30 seconds to bioactivate the implant sur-

face (test group). The implant on the other side was placed without embedding in PRGF liquid (control). The minimum insertion torque value for all the implants was 30 N/C. A healing cap was then attached to the implant. The flaps were repositioned and secured with non-absorbable 3-0 silk sutures. One hour before surgery 2 g of amoxicillin was prescribed and continued as 500 mg, 3 times a day for 1 week after surgery; 400 mg of Ibuprofen was prescribed 4 times daily for pain control if necessary. 0.2% chlorhexidine digluconate mouthwash was given twice daily for 1 week for plaque control. A soft diet was recommended. One week after surgery, the sutures were removed. The stability of implants was measured by a periotest device (Medizientechnik Gulden, Germany). The range of periotest values was from -9 to +50. The more negative values for periotest indicate higher stability of the implant. Periotest values were measured on the day of surgery and 1, 2, 4 and 8 weeks after surgery. The measurements were repeated 3 times every time and the mean was recorded.

Statistical Analysis

Variance analysis was used to compare the mean PTVs between the two groups. T-test was used to compare PTVs at different time interval.

Results

1. The mean values of PTVs were negative (good stability) at all time intervals in both the test and control groups.
2. In both the test and control groups, the highest mean stability of implants (most negative PTVs) were observed on the day of surgery and at 8th week interval.
3. In both the test and control groups, the lowest mean stability was observed in the 4th week after surgery.
4. There were no statistically significant differences between the test and control groups regarding mean PTVs at any time intervals (Table 1).
5. Comparing the mean PTVs in the control group at different time intervals, there were no statistically significant differences (P=0.140).
6. Comparing the mean PTVs in the test group at different intervals, there were statistically significant differences between different time intervals (P=0.008). The P-values for variance analysis showed significant differences between weeks 2 and 4 and the day of surgery (Table 2).

Discussion

The results of this study showed that in both groups the minimum stability was observed around the 4th week after surgery. This once again emphasizes the important curve of Raghavendra[19] that the lowest stability is observed between 3rd and 4th weeks after surgery. Therefore, loading implants about 4 weeks after surgery is not recommended. The results of this study also showed that embedding of implants in PRP had no additional effects on the stability of implants measured by the periotest device. This is consistent with the findings of the following studies: Monov[20] in a split-mouth design clinical trial similar to this study reported no additional beneficial effect of biactivated implants with PRP compared to the control group. No statistically significant differences were observed between stability of implants measured in 2 groups by Osstel device. Similarly, Weibrich[21] and Garcia[22] in 2 different animal studies found no statistically significant differences between implants bioactivated with PRP (test group) and control group in the amount of bone-to-implant contact (BIC). Birang also in an animal study showed no statistically significant differences in bone trabeculae and the type of bone regeneration between implants activated with PRGF and the control group.[23]

On the contrary, Fuerst[24] in an animal study on mini-pigs found statistically higher BIC values in test implants (bioactivated with allogenic PRGF)

Table 2. The level of significance of variance analysis at different weeks to day of surgery in test group

Comparison between weeks	P values
Week 1 to week 0 (day of surgery)	0.365
Week 2 to week 0 (day of surgery)	0.036 (significant)
Week 4 to week 0 (day of surgery)	0.002 (significant)
Week 6 to week 0 (day of surgery)	0.080
Week 8 to week 0 (day of surgery)	0.486

Table 1. The mean and SD of PTV in test and control groups at different time intervals

	Mean ± SD of PTVs in the test group	Mean ± SD of PTVs in the control group	P-value (T)
On the day of surgery	-3.12±2.38	-3.95±2.18	0.368
After 1 week	-2.89±2.39	-3.62±2.66	0.405
After 2 week	-2.25±2.39	-3.84±2.01	0.080
After 4 week	-1.02±2.71	-2.90±2.52	0.086
After 6 week	-1.98±2.18	-3.54±2.08	0.077
After 8 week	-2.60±1.80	-3.86±2.09	0.052

compared to the control group. The different methods could explain the findings of Fuerst work, which were different from this study. Fuerst filled the osteotomy site with allogenic PRGF but in this study implants in the test group were embedded in autogenic PRP for 30 seconds and then inserted into prepared osteotomy sites. In this regard, some review papers encourage the use of PRP. Davis[25] reported that the healing benefits of platelet-rich preparations along with the low risk and availability of simple preparation procedures should encourage more clinicians to incorporate platelet-rich products in their practice to accelerate healing, reduce adverse events and improve patient outcomes. But based on the review paper by Nikolidakis,[26] the reported clinical effects of PRP (compared with controls) were mostly minimal to moderate. Moreover, there was a wide variety in outcomes, as demonstrated by the large confidence intervals of the reported effects. Consequently, evidence of a beneficial effect of PRP in oral surgery is considered to be insufficient. In regard to beneficial effects of PRP, the following points are important to remember before their use:

1. Multiple platelet-rich preparations have been reported to improve wound and bone healing, such as platelet-rich plasma (PRP) and platelet-rich fibrin (PRF). The different methods employed during their preparation are important, as they influence the quality of the product applied to a wound or surgical site. In addition, the general protocol for preparing the platelet-rich product need to be considered during its preparation. For example, activation of the platelets is required for the release and enmeshment of growth factors, but the method of activation may influence the resulting matrix, growth factor availability and healing. Additionally, some methods enrich leukocytes as well as platelets, but others are designed to be leukocyte-poor.

2. Leukocytes have many important roles in healing and their inclusion in PRP results in increased platelet concentrations. Generally, TGF-β1 and PDGF levels were higher in preparations that contained leukocytes compared to leukocyte-poor PRP. However, platelet concentration might be the most reliable criterion for comparing different preparations.[24]

3. The current consensus about PRPs is based on a simple classification system dividing the many products into 4 main families, based on their fibrin architecture and cell content: pure platelet-rich plasma (P-PRP), such as the PRGF-Endoret technique; leukocyte- and platelet-rich plasma (LPRP), such as Biomet GPS system; pure platelet-rich fibrin (P-PRF), such as Fibrinet; leukocyte- and platelet-rich fibrin (L-PRF), such as Intra-Spin L-PRF. The 4 main families of products exhibit different biological properties and mechanisms, and obvious differences for clinical applications.[27]

Conclusions

The lowest stability of the implants was reported at about the 4th week. Although application of PRP on the implant surface might lead to better initial stability, the effect is not significant.

In fact, there is no general consensus about positive effects of PRPs. Some papers report beneficial effects in improving soft and hard tissue healing. On the other hand, others claim lack of scientific evidence for its use in oral and implant surgery. For this reason more randomized clinical trials are needed before recommendations for absolute clinical application of PRP can be made.

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