

Platelet Rich Plasma - Utilizing autologous growth factors for dental surgery to enhance bone and soft tissue grafts.

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(Photos at end of article)

Abstract:

The addition to a graft site of an easily obtained autologous concentrate of blood platelets, called platelet rich plasma (PRP), offers an improved quality and speed of healing for both hard and soft tissue. This article will outline the sequence of bone regeneration, the role of PRP in bone regeneration, the methods to acquire PRP and the uses for PRP in clinical practice.

With bone and soft tissue regeneration becoming more evident in many areas of dentistry, it becomes important to utilize methods for enhancement of these regeneration procedures. Bone and soft tissue regenerative procedures are applicable for the enhancement of alveolar ridges with respect to ideal pontic and papillae esthetics for fixed partial prosthesis. Regenerative procedures are also important for periodontal regeneration to support a healthy dental- alveolar complex and for the enhancement of bone for dental implant placement. It is important for both the referring dental practitioner and surgical dentist to be aware of the latest procedures that are available, so that patients can receive the best level of oral health care .

Platelet rich plasma (PRP) is an autologous source for growth factors obtained from a sample of a patients blood in a dental office setting via different centrifugation processes. The PRP obtained offers up to a 2.16 times increase in the maturation rate and substantially greater density of a bone graft procedure. 1 Soft tissue healing is also substantially improved through the application of PRP via increasing collagen content, promotion of angiogenesis, and increasing early wound strength.2 The Growth factors found in PRP regulate key cellular processes such as mitogenesis, chemotaxis, and cell differentiation and metabolism. 3

Growth factors are mostly large peptides or glycoproteins that are secreted by many cell types in response to trauma such as a bone graft. These peptides then act both locally and systemically in a self- regulating feedback loop system. 4

The application of PRP has the ability to enhance procedures such as sinus grafting, periodontal soft sand hard tissue surgical procedures, ridge augmentation for crown and bridge and improvement of dental implant osseous-integration.

Sequence of Bone regeneration:

To understand how PRP affects bone regeneration, the sequence of regeneration should be made clear. Platelets are cytoplasmic fragments of megakaryocytes that

circulate in the blood. They are responsible for hemostasis and the initiation of regeneration of tissue from trauma.

During a bone grafting procedure, platelets become entrapped in a graft clot and degranulate within hours releasing two growth factors. Platelet derived growth factor (PDGF) and Transforming growth factor beta (TGF-B).

PDGF binds to endothelial cells to initiate capillary ingrowth and TGF-B binds to osteoblasts and stem cells to initiate mitosis and stimulate osteoid production 1

Initially macrophages are attracted into the graft site through an oxygen gradient of 30-40 mm Hg . These macrophages then take over the role platelets started, and drive the remaining bone regeneration and healing process. The lifespan of platelets in a wound and their influence on growth factors is less than 5 days, therefore bone regeneration is extended by two mechanisms. The first mechanism is the stem cell increase into osteoblasts, which can then produce TGF-B. The second mechanism for bone regeneration extension is from macrophage replacement of platelets .

By day 14 complete revascularization of the graft is seen. Stem cells have differentiated into osteoblasts and osteoid is being laid down. Early bone formation is occurring.

At four to six weeks random cellular bone called woven bone is formed. This unorganized bone is immature and disorganized but there is sufficient mineralization to permit graft function.⁵ During phase two remodeling, lamellar bone is formed, representing a more organized bone which in turn further matures via functional loading with stresses placed on it.⁶ This fragile

process of cellular formation necessitates the immobility of the graft site, which is often done via membranes and titanium screws.

The role of PRP in regeneration:

Through the application of PRP to the bone graft wound site, a substantial increase in the platelet count is offered. This increases the availability for platelets to create the cascade response via PDGF and TGF-B. The average platelet count in a persons blood is between 111,000 to 523,000 as a mean platelet count. Through concentrating the platelets into PRP, the average platelet count increases to a range of 595,000 to 1,100,000. An average increase of 338%. 1 It should be understood that from an evolutionary level, it is inefficient for the body to have numerous stem mesenchymal cells that are just dedicated to healing. In fact stem cell populations decrease with age, lending to the fact younger people don't scar as much as older people. Platelets, which are only in the graft site for less than 5 days, allow the body to efficiently start a cascade reaction utilizing growth factors. 6

It can be considered that PRP "jump starts" the cascade of regenerative events leading to form a mature graft site.³

Obtaining and utilizing PRP:

PRP can be obtained in various ways in a dental office setting . In the literature, techniques for PRP preparation vary from using 10cc of a patients blood and spinning it in a lab centrifuge 7, to utilizing a unit of blood that is put through a cell separator, that sequester and concentrate the platelets.⁶ One in-office device from Harvest Technologies Corp, Norwell, MA, (fig 1) utilizes 45-55 cc of a patients blood obtained through venepuncture with a 17 gauge needle. This blood sample is then placed into an automated dual spin centrifuge, separating the blood into red blood cells, platelet poor plasma, and growth factor enriched platelet concentrate (PRP). This is all done in a very convenient way utilizing a disposable kit that supplies everything needed. (fig 2)

The Harvest "Smart Prep" machine works through initially adding citrate phosphate dextrose (CPD) to the blood sample for the purpose of anticoagulation. This blood sample containing CPD is then centrifuged in a

horizontal and vertically swiveling disposable carrier that yields 3 layers of blood. (fig3) The least dense layer, which is about 45% of the sample, is Platelet poor plasma (PPP). This PPP is acellular, and contains fibrinogen which can be used for soft tissue hemostatic management and healing. The middle layer of the original blood sample are Red blood cells (RBC). The RBC's make up around 40% of the original sample. This is disposed of as medical waste. The PRP layer is the lower layer and this makes up around 15% of the original sample. It is also called the "buffy" coat due to it's white or buffy appearance. (fig4) The final PRP sample is then mixed with 5ml of 10% calcium chloride and 5,000 units of topical bovine thrombin. The calcium chloride and the thrombin initiates the coagulation process, and creates ideal handling characteristics, which can be sprayed onto the graft site or added to a particulate graft. This coagulated PRP product can also be gelled into a membrane type structure that can be placed into a surgical site for improved healing and hemostasis.

Conclusion:

The availability to enhance the regenerative process of the human body, through utilizing a patient's own blood, is something that is now available and is substantiated in the literature. The application of PRP offers the dental patient something that is safe from outside disease transmission, or immunogenic reactions.

This PRP preparation can be easily obtained in a dental office environment and can be used for various procedures being done in a surgical dental practice. The growth factor enhancement is especially applicable for patients that are healing impaired such as the elderly. PRP appears to enhance both hard tissue and soft tissue healing through concentrated platelets and growth factors such as PDGF and TGF-B.

1. Marx RE, Carlson ER, Eichstaedt RM, et al. Platelet Rich Plasma. Growth factor enhancement for bone grafts, *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1998;85:638-46

2. Green, D, *Correspondance, Plastic And Reconstructive Surgery, April 1998; Vol 101, No4*

3. Garg A, *The use of platelet rich plasma to enhance the success of bone grafts around dental implants, Dental Implantology Update March 2000;Volume 11, Number 3*

4. Herndon D et al, *Growth Factors Local And Systemic, Arch Surg, Nov 1993;Vol 128*

5 . Marx RE, Garg AK, Bone Graft Physiology With The Use Of Platelet Rich Plasma and Hyperbaric Oxygen. In: Jenson OT (ed) *The Sinus Bone Graft*. Chicago, Quintessence, 1999, pp 183-189)

6 . Marx RE. Platelet rich plasma: A source of multiple autologous growth factors for bone grafts. In: Lynch SE, Genco RJ, Marx RE (eds). *Tissue Engineering: application in Maxillofacial Surgery and Periodontics*. Chicago, Quintessence, 1999, pp 71-82)

7. Misch CE, *Contemporary Implant Dentistry*, St. Louis, Mosby, 1999, p 463)



Figure 1



fig 2

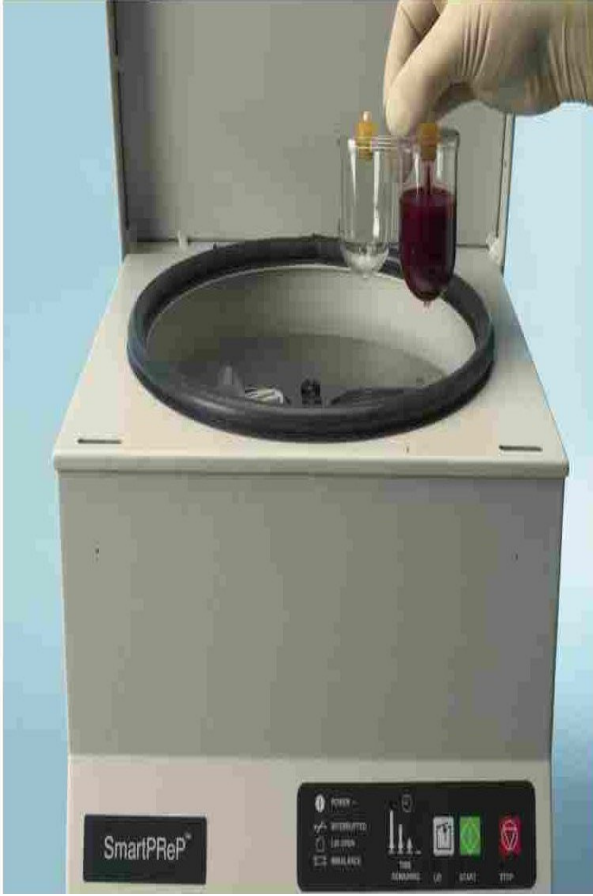




fig 4