

Using Platelet-Rich Plasma to Accelerate Soft Tissue Maturation in Esthetic Periodontal Surgery

CE 1

Abstract: *The transposition of connective tissue to increase the zone of keratinized tissue and/or for root coverage has become an integral part of the surgical dental practice. In an effort to reduce the incidence of postoperative complications occasionally observed with these procedures, the incorporation of platelet-rich plasma and its growth factors has been introduced into the surgical protocol. Documentation of several cases requiring esthetic soft tissue grafting procedures and the use of regenerative barriers to obtain root coverage with the incorporation of platelet-rich plasma is presented.*

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Since the inception of soft tissue grafting procedures nearly 50 years ago, the transposition of tissue from the palatal area has provided the periodontal surgeon with a reliable and predictable method of increasing the zone of keratinized tissue in the vestibular area.¹⁻³ Expansion of the grafting procedure to treat the recession of the gingival tissues and subsequent exposed root surfaces was perfected by Miller.⁴⁻⁶ Further developments in the structural as well as esthetic coverage of exposed root surfaces ensued.⁷⁻¹² With the increasing popularity of cosmetic dental procedures, root coverage procedures to enhance the level of keratinized tissue around exposed root surfaces has seen a rise in popularity over the last several years. Currently, enhancement of the keratinized gingival tissues to provide root coverage over an exposed root surface has become part of the contemporary periodontal surgeon's armamentarium.¹³⁻¹⁸ The periodontal surgeon has enjoyed a relatively high level of success with these root coverage procedures. However, potential complications still remain and can cause failure of the procedure (Table 1).

To circumvent some of the potential complications at the donor and receptor sites, additional procedures were developed to provide both an increase in the zone of keratinized tissue and coverage of the exposed root surfaces.¹⁹⁻²² The incorporation of acellular dermal matrix allografts^{23,24} and various guided tissue regeneration barriers²⁵⁻²⁹ eliminated the necessity of harvesting connective tissue from the palate. Although these procedures are less traumatic to the patient, the success rates have been variable.

In an attempt to increase the success rate of the connective tissue grafting procedure as well as to increase the successful use of tissue regeneration barriers to provide root coverage, the author has incorporated the use of platelet-rich plasma (PRP) into the surgical protocol.

PRP (autologous platelet gel) is developed from autologous blood with a cell separator.³⁰ A 60-mL syringe is pretilled with 5 mL of a citrate-based

Learning Objectives:

After reading this article, the reader should be able to:

- recognize the potential complications reported with connective tissue grafting.
- identify procedures that were developed to provide both an increase in the zone of keratinized tissue and coverage of the exposed root surface.
- list the growth factors found in platelet-rich plasma.
- recognize the benefits of incorporating the platelet-rich/platelet-poor plasma technique into connective tissue grafting procedures.

Table 1—Potential Complications Reported With Connective Tissue Grafting

• Failure of the connective tissue graft to revascularize (graft sloughage).	• Micromovement of the connective tissue graft, which leads to sloughage.
• Shrinkage of the connective tissue graft.	• Excessive bleeding at the donor site.
• Infection at the graft site.	• Excessive bleeding at the receptor site.
• Sloughage of the palatal tissues.	• Infection at the donor site.
• Prolonged pain/discomfort at the donor/receptor site.	



Figure 1A—Pretreatment view.



Figure 1B—Root preparation of teeth Nos. 8 and 9.



Figure 1C—PrefGel™ applied to the root surfaces.

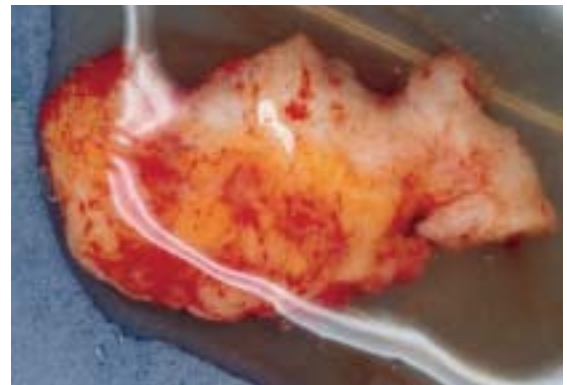


Figure 1D—The connective tissue graft immersed in PRP.

anticoagulant (ACD-A). For each 60-mL syringe, approximately 45 mL to 55 mL of the patient's blood is withdrawn from a venous puncture in the upper arm. The anticoagulated blood is dispensed into the blood chamber of the processing disposable. The blood must be drawn before the commencement of surgery, because surgery itself leads to platelet activation of the coagulation system.

A processing disposable is loaded into the centrifuge rotor cup of the Smart PReP™,^a Platelet Concentrate System. A counterbalance is then placed in the opposing rotor cup unless a second processing disposable is

required. During processing, the blood is initially centrifuged at 3,650 rpm to separate the red blood cells from the plasma. The centrifuge then slows to approximately 60 rpm, allowing the plasma to automatically decant into the plasma chamber. The centrifuge then accelerates to 3,000 rpm to form a pellet of pure plasma concentrate in the bottom of the plasma chamber. The entire process of separating the whole blood into red blood cells, platelet-poor plasma (PPP), and platelet concentrate is completely automatic and completed in approximately 12 minutes.

The blood chamber of the process disposable contains red blood cells. The second

^aHarvest Technologies Corporation, Plymouth, MA 02360; (508) 732-7500



Figure 1E—PRP applied to the root surfaces.



Figure 1F—The PRP/connective tissue graft seated over the exposed roots.



Figure 1G—Application of PRP followed by PPP, which acts as a growth-factor-impregnated surgical dressing.



Figure 1H—Two months after the connective tissue grafting procedure.

chamber contains the platelet concentrate (a buttonlike precipitate) and PPP (supernatant). Approximately two-thirds of the PPP is removed and can be saved for hemostatic applications. The platelet concentrate is then resuspended in the remaining PPP, thereby creating a very concentrated PRP solution.

The activator for the PRP and PPP is a mixture of 5,000 units of topical bovine thrombin and 5 mL of 10% calcium chloride. The activator is drawn into two 1-mL syringes and 10 mL of PRP is then drawn into one syringe and 10 mL of PPP is drawn into the other syringe. The two syringes are attached to a 20-gauge dual cannula applicator tip where the contents are mixed as they are applied into/onto the bone graft, wound, connective tissue graft, or incisions.

The following is a list of the growth factors found in PRP³¹:

- Platelet-Derived Growth Factor (PDGF)
- Transforming Growth Factor-beta (TGF- β)
- Platelet-Derived Endothelial Cell Growth Factor (PDECG)
- Platelet-Derived Angiogenesis Factor (PDAF)

- Insulinlike Growth Factor (IGF)
- Vascular Endothelial Growth Factor (VEGF)

Based on initial clinical observations from the author, incorporation of PRP/PPP into the connective tissue grafting procedure, and in the use of tissue regenerative barriers to obtain root coverage, has clinically shown a decrease in the complications associated with grafting procedures. In addition, the soft tissue maturation phase is accelerated and a decreased incidence of postoperative pain and/or swelling has been found.³¹⁻³³

The following case reports demonstrate how PRP and PPP can be used in root coverage procedures, along with demonstrating how PRP has assisted in the uptake of the connective tissue in two difficult cases. In the first case, the patient exhibited a wide zone of recession as well as a lack of bone support at the mesial and distal surfaces of the central incisors. The patient in Case 2 required root coverage at eight mandibular teeth, which exhibited deep, wide gingival recession. Case 3 demonstrates the use of tissue regenerative barriers to obtain root coverage, and how PRP



Figure 2A—Preoperative view (right lateral aspect).



Figure 2B—Preoperative view.



Figure 2C—Preoperative view (left lateral aspect).



Figure 2D—Root surface appearance after initial application of PRP.



Figure 2E—Connective tissue graft secured to the recipient site with an application of both PRP and PPP.

and the local distribution of growth factors assisted in the soft tissue maturation rate.

Case 1

A 44-year-old woman (nonsmoker) presented to the dentist for esthetic enhancement of the natural dentition with veneer restorations at teeth Nos. 4 through 13 (Figure 1A). After a completed work-up, which included obtaining a Master Diagnostic Model® (MDM®)^b of the areas to be treated, the dentist referred the patient to the periodontal

^bValley Dental Arts, Stillwater, MN 55082; (800) 328-9157

office for a root coverage procedure at teeth Nos. 8 and 9. The root coverage procedures would not only obtain 3 mm of root coverage, but would also increase the thickness of the keratinized tissue buccally. After sulcular inci-

The cohesive nature of the platelet-poor plasma, along with its inherent hemostatic properties, virtually eliminates the incidence of bleeding from the palatal site.

sions and conservative flap elevation (Figure 1B), extensive root planing was accomplished from the mesial of tooth No. 7 to the distal of tooth No. 10. Ethylenediaminetetraacetic acid (EDTA) (PrefGel™^c) was applied to the root surface for 4 minutes to remove the smear layer remaining on the root surfaces after removal of the exposed cementum (Figure 1C). After copious irrigation to remove the EDTA, the prepared root surfaces were ready to receive

^cBiora, Inc., Chicago, IL 60610; (888) BIORA-US



Figure 2F—Closure with PRP and PPP applied as the growth-factor-impregnated surgical wound dressing.



Figure 2H—The 3-month postconnective tissue grafting.



Figure 2G—Right lateral view 3-months after the postconnective tissue grafting.



Figure 2I—Left lateral view 3 months after connective tissue grafting.

the connective tissue graft. Harvesting of the required amount of connective tissue from a small window in the palate was performed before initiation of incisions at the receptor site. After the required amount of connective tissue was harvested, the tissue was coated with the PRP to allow the growth factors to impregnate the connective tissue (Figure 1D) while the surgeon was preparing the recipient site. Without PRP, the surgeon would harvest the connective tissue after preparation of the recipient site, and then place the connective tissue in a saline gauze while he or she obtained closure at the donor site. The tissue would be separated from its blood supply in the gauze with only saline keeping the graft moist. In this case, before closure of the donor site the surgeon applies PPP both inferiorly and superiorly to the palatal tissue. The cohesive nature of the PPP, along with its inherent hemostatic properties, virtually eliminates the incidence of bleeding from the palatal site. After closure of the palate, the surgeon proceeds.

Before securing the growth-factor-impregnated connective tissue graft, PRP is applied to the exposed, prepared root surfaces (Figure

1E). In these initial surgical procedures, the author has observed that the PRP delivers growth factors to enhance the soft tissue healing and maturation rate, but also promotes a more rapid revascularization rate of the grafted connective tissue. In addition, the cohesive properties of the PRP, which can be compared to a growth-factor-impregnated fibrin glue, act to stabilize the graft, and, along with the proper suturing method, decrease the potential of micromovement of the graft.³¹⁻³³

Placing the connective tissue graft and securing the graft by stay sutures precedes another application of the PRP, followed by application of the PPP, which acts as a growth-factor-impregnated regenerative membrane (Figure 1F). After closure with 5.0 Monocryl sutures^d by a combination of continuous sling and horizontal mattress suturing techniques, an additional application of PRP, followed by application of the remaining PPP (Figure 1G) forms a growth factor surgical dressing. This dressing not only protects the grafted root surface, but also delivers growth factors specific for soft tissue healing and mat-

^dETHICON, INC., Somerville, NJ 08876; (800) 255-2500



Figure 3A—Pretreatment view of teeth Nos. 3 and 4.



Figure 3B—Pretreatment view of teeth Nos. 7 and 8.

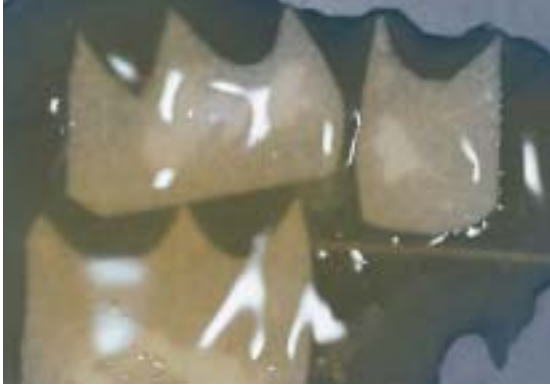


Figure 3C—BioMend™ membrane reconstituted in PRP.



Figure 3D—Collagen membrane (PRP reconstituted) secured to the buccal surface of teeth Nos. 7 and 8.

uration to the surgical site.³¹⁻³³ The 2-month postoperative view can be seen in Figure 1H. Note how the PRP-enhanced root coverage procedure has satisfied the original surgical goals, which were root coverage of 3 mm and increasing the thickness of the buccal keratinized tissue.

This case was difficult to manage because of the buccal position of the roots of the central incisors and the lack of bone support, which would have aided in the revascularization of the graft. Nevertheless, the goals of this case were achieved in the 2-month time frame. In addition, the patient's surgical experience was pleasant, and she experienced minimal postoperative pain and virtually no postoperative bleeding.

Case 2

A 46-year-old woman (nonsmoker) presented for the treatment of deep, wide gingival recession at teeth Nos. 21 through 28 (Figures 2A through 2C). The patient had undergone a free gingival graft by another surgeon many years earlier at the mucogingival junction. Connective tissue was obtained from the palate following the procedure described in

Case 1. In this case, tissue was harvested from both sides of the palate, and PRP was applied to the donor tissue while the preparation of the recipient site was accomplished.

After the initial incisions and reflection of a full-thickness mucoperiosteal flap, the root surfaces were planed to remove the exposed cementum. After burnishing the root surfaces with citric acid at a pH level of 1 for 4 minutes to remove the smear layer remaining from the root planing procedure, PRP was applied to the exposed root surfaces (Figure 2D). The growth-factor-impregnated connective tissue graft was then secured, and additional applications of PRP followed by PPP were accomplished (Figure 2E). Additional stabilization of the graft was obtained using a suturing method, which included a combination of continuous sling, horizontal, and vertical mattress sutures with 5.0 Monocryl. Before dismissing the patient, additional applications of PRP followed by PPP acted as a growth-factor-impregnated surgical dressing (Figure 2F).

At the 2-month postoperative period, a tissueplasty procedure was necessary to reduce the bulk of keratinized tissue obtained from the procedure. A 3-month post-PRP/connective



Figure 3E—Additional PRP and PPP applied over the barrier membranes at surgical site Nos. 7 and 8.



Figure 3F—Closure of sites Nos. 7 and 8.



Figure 3G—Three months after the root coverage procedure using PRP and barrier membranes at teeth Nos. 3 and 4.



Figure 3H—Three months after the root coverage procedure using PRP and barrier membranes at site No. 10.

tissue grafting procedure view can be seen in Figures 2G through 2I. Although this was a difficult case because it required treatment in multiple sites as well as a deep, wide recession, the original goals of root coverage were obtained in a relatively short time period. The patient also experienced little or no postoperative pain or bleeding at the recipient site or the donor site, which included both sides of the palate.

Case 3

A 41-year-old woman (nonsmoker) presented for treatment of gingival recession at teeth Nos. 3, 4, 7, 8, and 10 (Figures 3A and 3B). She also requested esthetic enhancement of her natural dentition with a combination of veneer and full-coverage restorations at teeth Nos. 3 through 14. The patient had previously undergone free gingival grafting to increase the zone of keratinized tissue at teeth Nos. 20 through 29, and had tissue harvested from both sides of the palate. As a result of the decrease in the amount of connective tissue at the palate, the patient opted for using regenerative barriers to increase not only the kera-

tinized tissue for root coverage, but also to regenerate bone at the buccal surfaces of the teeth to be treated.

A BioMend^{TM,e} collagen membrane measuring 30 mm × 40 mm was selected, and separated into three sections. After customizing the barriers to the desired shapes, the collagen membranes were reconstituted with PRP for ease of handling and saturation with growth factors (Figure 3C). The PRP/collagen membranes can stand while the surgical sites are prepared. After the prescribed incisions and root preparation procedures, and application of PRP to the prepared root surfaces, the PRP/collagen membranes were seated and secured at teeth Nos. 3, 4, 7, 8, and 10 (Figure 3D). After the initial stabilization of the barriers, additional PRP, followed by PPP was applied over the surgical sites (Figure 3E). Closure was then obtained by a continuous sling and horizontal mattress suturing method with 5.0 Monocryl suture (Figure 3F). An additional application of PRP followed by PPP over the surgical site served as a growth-factor-impregnated surgical dressing.

^eSulzer Dental Inc., Carlsbad, CA 92008; (760) 929-4300

A 3-month postoperative view can be seen in Figures 3G and 3H. The patient received her final ceramic restorations within this time frame, and experienced virtually no postoperative pain or bleeding after the initial surgical procedure. In addition, the zone of keratinized tissue was increased at the buccal surfaces of teeth Nos. 3, 4, 7, 8 and 10. Root coverage was also obtained.

The use of platelet-rich plasma promotes a more rapid revascularization of the transposed connective tissue by delivering growth factors specific for capillary formation.

Conclusion

The author has found that incorporating the PRP/PPP technique into connective tissue grafting procedures and procedures using regenerative membranes to obtain root coverage has been demonstrated to enhance the healing and soft tissue regeneration process in root coverage procedures.

Based on the author's clinical evaluations and observations, the use of PRP in these procedures provides the following benefits:

- Decreases the incidence of both intraoperative and postoperative bleeding at the donor and receptor sites because of its inherent hemostatic properties.
- Decreases the incidence of postoperative pain at the donor and receptor sites by facilitating a more rapid soft tissue healing and maturation rate.
- Aids in the initial stabilization of the transposed connective tissue at the recipient site as a result of its inherent cohesive and adhesive properties.
- Promotes a more rapid revascularization of the transposed connective tissue by delivering growth factors specific for capillary formation directly to the graft, the root surfaces, and the undersurface of the flap.
- Decreases the potential for postoperative infection and/or graft sloughage as the PRP promotes a more rapid uptake and maturation of the graft.

In addition, when using tissue regenerative membranes, the following benefit is also obtained:

- Localized delivery of growth factors specific for the regeneration of bone at the inferior (root surface) aspect of the regenerative barrier.³³

The author has observed a possible added benefit that patients undergoing these procedures heal more rapidly, and with less pain, swelling, and postoperative bleeding, and can return to their normal daily activities in a shorter time frame than was previously observed. Additional controlled clinical studies and evaluations are necessary, but the conclusions of the author demonstrate the potential benefits of adding PRP to the surgical protocol.

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Quiz 1

1. PRP is developed from autologous blood with a:
 - a. precipitating agent.
 - b. cell separator.
 - c. chemical reaction.
 - d. gel suspension.
2. The entire process to separate the whole blood into red blood cells, PPP, and platelet concentrate is completely automatic and completed in approximately:
 - a. 8 minutes.
 - b. 10 minutes.
 - c. 12 minutes.
 - d. 20 minutes.
3. Incorporation of PRP/PPP into the connective tissue grafting procedure has clinically:
 - a. shown a decrease in complications.
 - b. required a decrease in suturing.
 - c. decreased available insulin-like growth factor.
 - d. increased tissue quantity.
4. In Case 1, application of EDTA to remove the smear layer was allowed to treat the root surface for:
 - a. 1 minute.
 - b. 2 minutes.
 - c. 3 minutes.
 - d. 4 minutes.
5. After the required amount of connective tissue was harvested, the tissue was:
 - a. stretched by 2 mm.
 - b. stretched by 4 mm.
 - c. coated with the PRP.
 - d. placed in a centrifuge.
6. The cohesive nature of the PPP, along with its inherent hemostatic properties, virtually eliminates:
 - a. the incidence of infection.
 - b. the incidence of pain.
 - c. the incidence of bleeding.
 - d. the need for sutures.
7. The cohesive properties of the PRP can be compared to a:
 - a. platelet-derived angiogenesis factor.
 - b. transforming factor beta.
 - c. growth-factor-impregnated fibrin glue.
 - d. vascular endothelial cell factor.
8. In Case 2, burnishing the root surfaces with citric acid was done at a pH of:
 - a. 1.
 - b. 6.
 - c. 7.
 - d. 12.
9. PRP promotes a more rapid revascularization of the transposed connective tissue by delivering growth factors specific for:
 - a. venous formation.
 - b. capillary formation.
 - c. lymphatic formation.
 - d. arteriole formation.
10. PRP decreases the potential for postoperative infection and/or graft sloughage as it promotes a more rapid:
 - a. vasovagal response.
 - b. delivery of potential rejection factor.
 - c. uptake and maturation of the graft.
 - d. thermal cellular response.

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