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Use of platelet gel with connective tissue grafts for root coverage: a randomized-controlled trial

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Abstract

Background: Platelet-rich plasma (PRP) was speculated to be a promoter of periodontal regeneration. There are only a few clinical comparative studies using PRP in the treatment of gingival recession.

Aim: The aim of the present study was to compare connective tissue graft (CTG)+PRP with CTG alone in the treatment of gingival recession.

Material and Methods: Forty patients with Miller I/II recessions were included. Each recession was randomly treated with either CTG+PRP or CTG. Clinical variables were recorded at baseline and at 6 weeks, 6 and 12 months. Root coverage (RC) and attachment gain (AG) were also calculated.

Results: Probing depth, recession depth, clinical attachment level, keratinized tissue width and recession width (RW) were improved in both study groups. However, no difference was observed between groups, except RW. RW in the control group was statistically lower than the test group at all follow-up periods.

Conclusion: Treatment of recession with CTG or a CTG–PRP combination resulted in favourable clinical outcomes. However, no difference could be found between CTG and CTG+PRP. Whether much longer follow-up studies with higher statistical power may change these results remains questionable.

Key words: comparison studies; connective tissue graft; gingival recession; periodontal plastic surgery; platelet-rich plasma; root coverage

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Gingival recession is a common, undesirable apical shift of the marginal tissue beyond the cemento-enamel junction (CEJ) and may cause inadequate dimensions of keratinized tissue and aesthetic problems. The increasing interest in aesthetics and the subsequent need to solve related problems such as hypersensitivity and root caries have favoured the development of many surgical procedures that allow the coverage of exposed roots. The evidence for the efficacy of periodontal plastic surgery in reducing gingival recession and improving attachment level has been systematically reviewed (Roccuzzo et al. 2002). Connective tissue graft (CTG) covered by a coronally positioned flap (CPF) is one of the valid surgical options and is used frequently due to its good predictability (Wennström & Zucchelli 1996, Paolantonio et al. 2002, Tozum et al. 2005)

Increasing interest has been focused on the regeneration and early wound healing of supporting structures, where platelet-rich plasma (PRP) was speculated to be a promoter of tissue regeneration and alveolar bone formation (Tozum & Demiralp 2003, Okuda et al. 2005). PRP is acomponent of blood, in which the platelets are concentrated in a limited volume of plasma (Marx 2001). The medical literature provides evidence that platelets contain many growth factors including platelet-derived growth factor (PDGF), insulin like growth factor (IGF), transforming growth factor-β (TGF-β), which regulate key cellular events in tissue regeneration including cell proliferation, chemotaxis, differentiation and matrix synthesis (Pierce et al. 1991, Ojima et al. 2003). This autologous plasma is a rich source of growth factors and it has been thought that its application may provide effective results for inducing early tissue healing and regeneration (Marx et al. 1998). The first dental clinical results with PRP have been reported by Marx et al. (1998), and they suggested that adding PRP to bone grafts accelerate may the rate and

Conflict of interest and source of funding statement

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degree of bone formation in human mandibular defects. Encouraging effects of PRP have been shown in various surgical procedures including ridge or sinus augmentations (Mannai 2006, Consolo et al. 2007), periodontal flap surgery (Okuda et al. 2005), periapical surgery (Demiralp et al. 2004), intentional replantation (Tozum et al. 2006) and treatment of peri-implantitis (Petrungaro 2002). On the contrary, recent studies have also shown that PRP did not have additional influence on periodontal outcomes (Christgau et al. 2006, Klongnoi et al. 2006, Demir et al. 2007, Döri et al. 2007).

There are only a few reports documenting the use of PRP in aesthetic periodontal surgery. Petrungaro (2001) published a case series in which PRP, CTG and collagen membranes were used to cover gingival recessions. In one of these cases, CTG was embedded in the platelet gel at first and PRP gel was also applied to the exposed root surface. Then, a PRP-impregnated graft was placed on the surface and the site was covered with the overlying flap. The 2-month results including 3 mm RC were satisfactory. Cheung & Griffin (2004) compared a platelet concentrate graft and CTG for treating bilateral gingival recessions in 15 patients. They concluded that both techniques can effectively treat shallow Miller Class I or II buccal recessions. They also stated that treatment with the platelet concentrate graft may result in a better aesthetic appearance. The same authors also published a case report in which they used a platelet concentrate graft in a collagen sponge carrier, combined with a CPF procedure, and obtained complete RC and aesthetic results (Griffin & Cheung 2004). According to the results of different surgical procedures in oral and periodontal surgery, it may be thought that PRP can provide positive contributions to the wound healing and treatment outcomes of the RC techniques.

To our knowledge, there is only one published randomized-controlled study comparing the efficacy of CTG alone and combined with PRP on RC. In this study, Jankovic et al. (2007) evaluated and compared the clinical effectiveness of PRP in the standard treatment of gingival recessions with CTG. The results of this study confirmed both procedures as being effective and highly predictable surgical techniques in solving gingival recession problems. However, PRP in conjunction with CTG did not demonstrate different root coverage (RC) and attachment gain (AG) outcomes compared with CTG only. Only more keratinized tissue increase and advanced tissue healing results were obtained in the combination group of this controlled trial. The objective of the present study was to compare the results obtained by CTG or CTG+PRP to achieve clinical outcomes at 1-year follow-up in the treatment of gingival recession. Furthermore, the influence of platelet number increase and the level of alveolar bone to the RC and AG were also investigated.

Material and Methods

Patient selection

The study protocol was approved by the Institutional Committee of Ethics in Dental Research of the Faculty of Dentistry at Hacettepe University, Ankara, Turkey. Each patient was also given detailed information about the surgical procedure, PRP preparation and the expected success or failures related to CTG before surgery, and an informed consent form was signed. The study was carried out during the period May 2003 to December 2006 at the Department of Periodontology, Hacettepe Universtiy, Ankara, Turkey. Forty systemically healthy patients, each with one Miller's Class I or II buccal recession defect (Miller 1985), were included in this study. They had no known allergies, and all were non-smokers. Their complaints were related to missing aesthetics and hypersensitivity while tooth brushing. Following their examination, complete-mouth scaling and polishing were performed and oral hygiene instructions were given. At the end of the hygienic phase, patients displaying full-mouth plaque and bleeding scores less than 15% were included in the surgical phase. None of the patients used a traumatic brushing technique, hard bristle brushes or abrasive toothpastes.

Clinical measurements

All measurements were performed by one of the investigators (H. G. K.) not aware of the type of surgical procedure. Intra-examiner calibration was achieved by examination of two patients twice, 48 h apart before the beginning of the study. Calibration was accepted if measurements at baseline and at 48 h were similar to the 0.5 mm at the 90% level. The following measurements were taken at baseline (BL), 6 weeks (PS_1), 6 months (PS_2) and 12 months (PS_3) after periodontal plastic surgery using a Michigan O periodontal probe:

- recession depth (RD): distance from CEJ to the gingival margin;
- probing depth (PD): distance from the gingival margin to the base of the gingival crevice;
- clinical attachment level (CAL): distance from CEJ to the base of the gingival crevice;
- keratinized tissue width (WKT): distance from the gingival margin to the mucogingival junction (MGJ);
- recession width (RW): horizontal distance from one border of the recession to another at a line tangent to CEJ;
- localization of the MGJ (MGJ_L): distance from CEJ to MGJ.

Plaque index (PI) (Silness & Löe 1964) and gingival index (GI) (Löe & Silness 1963) were also assessed at BL as well as 6 weeks, 6 and 12 months post-surgery. Further, an intra-operative measurement was performed by the surgeon from CEJ to the most coronal point of the alveolar crest (CEJ-AC). The measurements were achieved at the mid-buccal aspects and rounded to the nearest 0.5 mm. The first patient was selected in one of the two experimental groups by coin toss, and the next patient was consecutively added to the opposite group by one of the authors (A. B.). The first group included 20 patients treated with CTG (control group). The second group also included 20 patients treated with CTG+PRP (test group). The percentage of RC and AG was calculated according to the following formulas:

$$\mathrm{RC}\% = \frac{\text{Preoperative RD} - \text{Postoperative RD}}{\text{Preoperative RD}} \times 100$$

$$\mathrm{AG}\% = \frac{\text{Preoperative CAL} - \text{Postoperative CAL}}{\text{Preoperative CAL}} \times 100$$

Surgical procedure

Surgical procedures in both study groups were performed by one surgeon (D. S.), and are shown in Figs 1 and 2. Ultracain D-S forte (Hoechst Roussel,

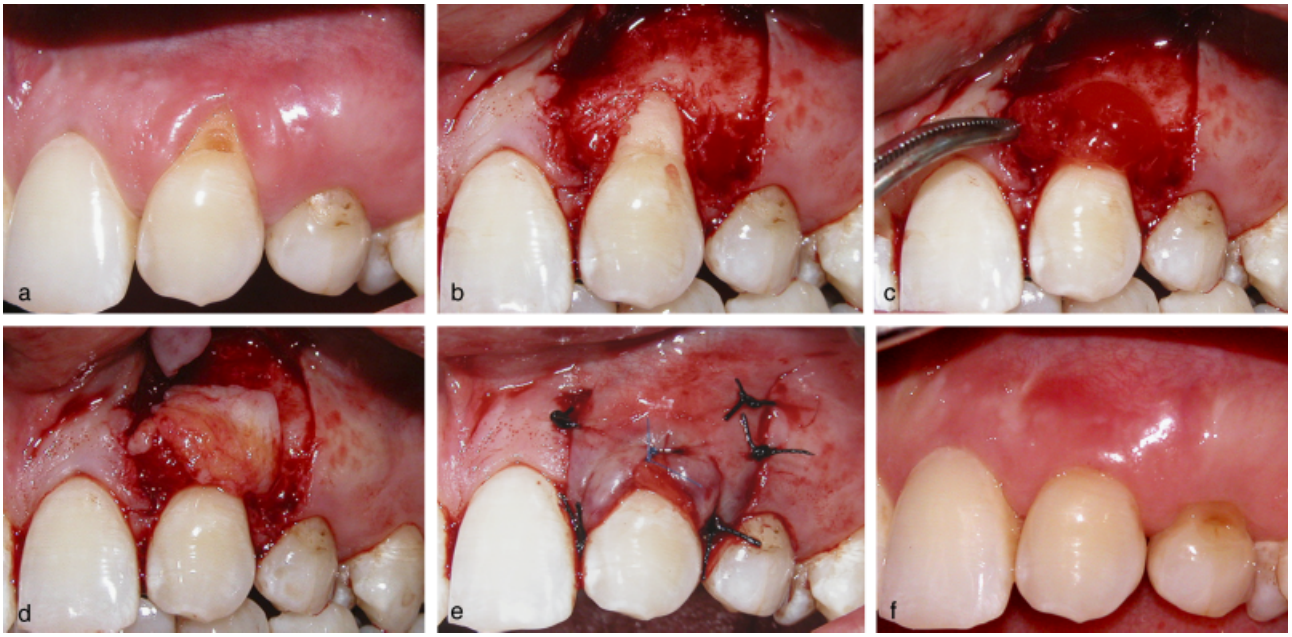

Fig. 1. Surgical procedure, test group.

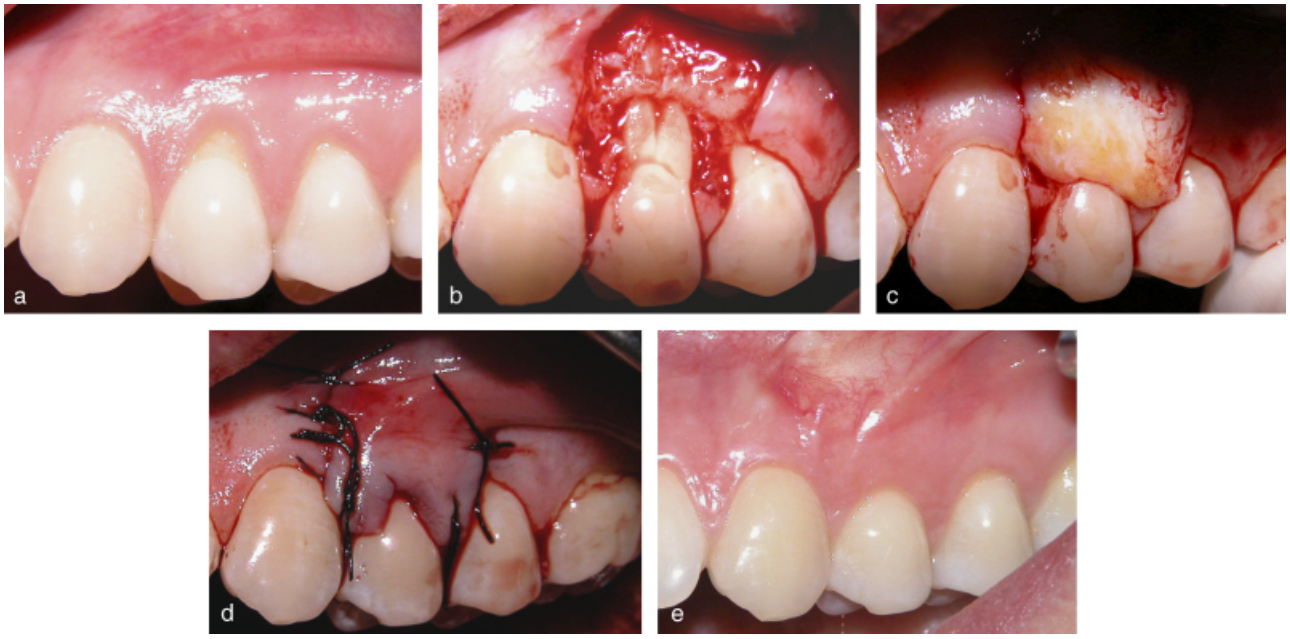

Fig. 2. Surgical procedure, control group.

Frankfurt, Germany) was administered to donor and recipient sites to achieve anaesthesia. Root planing of exposed root surfaces was carried out to reduce convexity and thus decrease the avascular surface area under the graft. The area was irrigated with sterile saline. The coronal margin of the flap was started with a horizontal sulcular incision to preserve all existing facial gingiva at least one-half to one tooth wider mesiodistally than the area of gingival recession. Two vertical incisions were performed from the endpoints of the horizontal incision to beyond the MGJ. Partial-thickness flap was elevated with sharp -dissection, and extended as far as necessary to allow for flap advancement to the CEJ without tension. A measurement of the approximate width necessary for the graft was determined with a periodontal probe. As a difference in the PRP group, a full-thickness flap was raised to achieve better contact between the platelet gel and the alveolar bone enclosing the recession defect. A second surgical site was created on the palate, where the location of the greater palatine neurovascular bundle was carefully considered. An incision was placed between the distal aspect of the canine and the mid-palatal region of the first molar area with a single-incision technique (Hurzeler & Weng 1999). CTG was harvested in adequate dimensions, allowing complete coverage of the

surgically exposed root surface and adjacent bone margins. Pressure was applied to the donor area with a gauze soaked in saline after the graft was taken. The donor area was closed with silk 5-0 sling sutures (Dogsan, Yalincak, Trabzon, Turkey). The graft was trimmed to remove abundant fatty parts and to a thickness of about 1.5–2 mm with a sharp surgical blade, if necessary, and was introduced into the recipient area. Unlike the control group, the graft was embedded immediately in the first portion of PRP and combined with an equal volume of sterile saline solution containing 10% calcium chloride (a citrate inhibitor that allows the plasma to coagulate, STA, Diagnostica Stago Inc., Parsippany, NJ, USA) and blood from operative area to allow growth factors to impregnate connective tissue in the CTG+PRP group (Marx 1999, Robiony et al. 2002) (Fig. 3). The second portion of PRP was placed in contact with bone and combined with the same amount of calcium chloride and surgical blood in place. Operative blood includes thrombin, which is an activator that allows polymerization of the fibrin into an insoluble gel and causes the platelets to degranulate and release growth factors into the surgical area (Marx 1999). Then, CTG was placed over the gel. Graft immobilization was carried out with a bioabsorbable 6-0 sling suture (Ethicon, St.-Stevens-Woluwe, Belgium) and tied on the palatal/lingual aspect of the tooth. The buccal/labial flap was pulled over a major portion of the CTG. The recipient flap was then sutured directly over the graft with silk 5-0 sutures. Donor tissue was covered with the overlying flap as much as possible to provide more blood supply to the graft. Vertical incisions were also closed with silk 5-0 sutures. A mild compress with gauze soaked in saline was applied for 5 min.

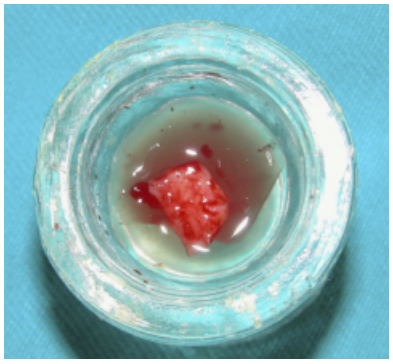

Fig. 3. Connective tissue graft embedded in platelet gel.

Post-operative care

A dry foil was applied to the recipient area for both groups, and then a non-eugenol periodontal dressing (Voco Pac, Cuxhaven, Germany) was placed over the dry foil to stabilize and protect the donor tissue for 10 days post-operatively. Patients were given a cold compress extra-orally to minimize swelling and bleeding the in post-operative period. They were prescribed 0.12% chlorhexidine gluconate (Klorhex, Drogsan, Ankara, Turkey) and instructed to rinse gently twice daily for 3 weeks. Tooth-brushing activities around the surgical sites were discontinued during this time. They were also given antibiotics (amoxicillin, 500 mg, three times daily, Largopen, Bilim Ilac, Istanbul, Turkey) for 7 days to prevent post-surgical infection.

PRP preparation

The preparation of PRP was performed during the immediate pre-operative period using the Curasan technique, which was described by Weibrich et al. (2001). Briefly, 8 ml of venous blood was obtained and spun in a standard centrifuge (Heraeus Labofuge 300, Kendro Laboratory Products, Osterrode, Germany) for 10 min. at 419 × g. After exclusion of red blood cells, a second centrifugation (15 min. at 942 × g) was performed with the remaining portion to concentrate the platelets. For each 8 ml of blood, the volume of supernatant PRP was about 0.7–0.8 ml, and was immediately separated into three portions. The first portion (0.3–0.4 ml) was treated with CTG and the second portion (0.2–0.3 ml) was applied to the defect site in combination with a calcium chloride solution and blood as described previously in the ''surgical procedure''. The third part (0.2–0.3 ml) of PRP and whole-blood samples of the patients was submitted to an electronic platelet counter machine (Gen-S System 2, Beckman Coulter Inc., Miami, FL, USA) to identify the number of platelets.

Statistical analysis

A statistical software program, SPSS for Windows version 11.5 (2002, SPSS Inc., Chicago, IL, USA), was used for data analysis. The Friedman test was used for within-group comparisons. Post-hoc comparisons were also performed and all times were compared with each other. The Mann–Whitney test was used for inter-group (CTG+PRP *versus* CTG) comparisons. The significance level of 0.05 was used in all statistical evaluations.

Correlation analysis

The possible influence of platelet number increase and CEJ-AC on RC% and AG% was assesswd using Spearman's correlation coefficient analysis. The correlation coefficient r_s was determined.

Power analysis

An a priori statistical power analysis using a software program (PC-Size, Dallal GE, Boston, MA, USA) was performed considering that the test and control groups were not independent, under the hypothesis of normality for the variables examined. Calculations at the 5% significance level showed that 15 patients were sufficient to detect a difference of 1.0 ± 1.5 mm in change in GR and CAL, with a 70% statistical power while it was 80% for 20 patients (Del Pizzo et al. 2005). This level of statistical power was assumed to be acceptable to demonstrate differences between the test and control groups.

Results

The post-operative healing was generally uneventful. Minor complications were related to usual post-operative swelling and occurred within the first days after surgery. Immediate post-operative bleeding at the donor site occurred in one patient from the CTG group and was easily managed by a sterile gauze compression. All patients participated until the end of 6 months; however, 17 patients from the CTG+PRP group and 19 patients from the CTG group could complete the 12-month follow up (Fig. 4). The clinical characteristics of the patients and the distribution of the recession sites are shown in Table 1.

Statistical analyse for the clinical variables at BL, 6 PS_1, 6 PS_2 and 12 PS_3 for both groups are presented in Table 2. The BL and follow-up values did not show any differences between the test and control groups. Within-group analysis demonstrated significant improvements in RD, CAL and WKT compared with BL for both study groups at PS_1, PS_2 and PS_3 ($p < 0.01$) (Table 2).

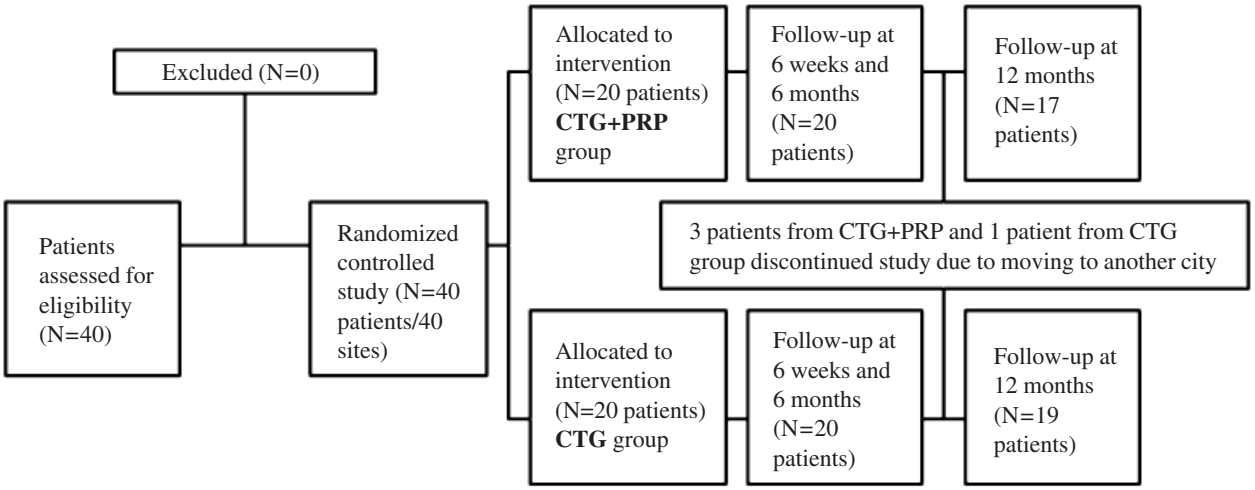

Fig. 4. Diagram of the study design.

Table 1. Study population demographics

	CTG	CTG+PRP	Total
Age			
Median (range)	36 (16–60)	40 (20–52)	38 (16–60)
Gender			
Male	3	7	10
Female	17	13	30
Tooth			
Lower incisor	3	5	8
Lower canine	3	1	4
Lower premolar	2	8	10
Upper canine	10	5	15
Upper premolar	2	1	3
Complaint			
Esthetics	4	4	8
Esthetics and sensitivity	13	10	23
Sensitivity	3	6	9
Recession type			
Miller I	16	11	27
Miller II	4	9	13

CTG, connective tissue graft; PRP, platelet-rich plasma.

Median values of 5.0 and 5.3 mm were identified for the localization of MGJ at BL in CTG+PRP and CTG groups, respectively, and the distance did not show significant change from BL to the follow-up visits in both the study groups. In addition, no statistically significant difference was found between study groups at BL, PS_1, PS_2 and PS_3 (Table 2).

RW values decreased after the surgery in both the study groups ($p<0.01$). However, the decrease from BL to the first follow-up in the test group was not statistically significant. Although the RW values of the test and control groups were similar at BL, statistical differences were determined at sequential follow-up visits ($p<0.01$) (Table 2).

On comparison at PS_1, PS_2 and PS_3, the median values and percentages of RC and AG were similar and did not change from the first to the third follow-up visit in both the study groups. The number of sites that demonstrated complete RC was eight (40%) and nine (45%) at PS_1, seven (35%) and nine (45%) at PS_2 and six (30%) and eight (40%) at PS_3 in the CTG+PRP and CTG groups, respectively (Table 3).

The median value of the distance from CEJ to AC was six for both groups and the variables were not statistically different (Table 4). The platelet count from whole-blood samples was 173.000/mm^3, while it was 768.500/mm^3 in the platelet concentrated samples. There was an approximately fourfold increase in the platelet counts after PRP preparation (Table 4). When the mean increase in platelet number was correlated with the treatment outcomes, significant correlation values were not obtained (Table 5). Correlation analysis evaluating the influence of CEJ-AC on the therapeutic outcome variables revealed that the level of AC in the CTG group was negatively correlated with RC (PS_1: $r_s = -0.575$; PS_2: $r_s = -0.457$; PS_3: $r_s = -0.613$). However, weak correlation values were observed for the CTG+PRP group. Further, AG percentages did not reveal any significant positive or negative correlations with the other evaluated variables for both the study groups (Table 5).

Discussion

Before performing mucogingival surgery, the practitioner should select the most predictable way to achieve successful RC. Several trials demonstrated successful results of RC and AG when CTG was used to cover buccal gingival recessions. Briefly, Paolantonio et al. (2002) (89% RC), and Zucchelli et al. (1998) (93.5% RC), Jepsen et al. (1998) (86.9% RC) achieved successful RC at their 1-year evaluation. The results of the present study, in which 86% RC was achieved at the 12-month follow up with the CTG procedure, are in agreement with these studies. Furthermore, the median value of 3.0 mm in AG achieved 1 year following the CTG technique is within the range of results reported from previous studies on the same surgical procedure (Ricci et al. 1996, Jepsen et al. 1998, Paolantonio et al. 2002).

While the initial results obtained by the application of PRP in periodontal plastic surgery demonstrated positive findings regarding of RC and aesthetic

Table 2. Baseline and follow-up clinical parameters

	CTG+PRP		CTG	
	median	range	median	range
GI				
Baseline	0.0	0.0–2.0	0.0	0.0–1.0
PS_1	0.0	0.0–1.0	0.0	0.0–2.0
PS_2	0.0	0.0–1.0	0.0	0.0–1.0
PS_3	0.0	0.0–2.0	0.0	0.0–1.0
PI				
Baseline	0.5	0.0–3.0	0.0	0.0–3.0
PS_1	0.0	0.0–2.0	0.0	0.0–3.0
PS_2	0.0	0.0–1.0	0.0	0.0–1.0
PS_3	0.0	0.0–2.0	0.0	0.0–1.0
RD (mm)				
Baseline	3.3	3.0–5.0	3.0	3.0–5.0
PS_1	0.5*	0.0–1.5	0.5*	0.0–2.0
PS_2	0.5*	0.0–1.5	0.5*	0.0–2.0
PS_3	0.5*	0.0–1.5	0.5*	0.0–2.0
RW (mm)				
Baseline	3.8	2.0–5.0	3.0	2.0–5.0
PS_1	3.0†	0.0–5.0	0.0*	0.0–3.0
PS_2	3.0*,†	0.0–5.0	0.5*	0.0–3.0
PS_3	2.5*,†	0.0–5.0	0.0*	0.0–3.0
PD (mm)				
Baseline	1.0	1.0–2.0	1.0	1.0–3.0
PS_1	1.0	1.0–2.0	1.0	1.0–2.0
PS_2	1.0	1.0–2.0	1.0	1.0–3.0
PS_3	1.0	1.0–2.0	1.0	1.0–3.0
WKT (mm)				
Baseline	1.3	0.0–6.0	2.0	0.0–5.0
PS_1	4.8*	2.0–7.0	4.3*	1.0–8.0
PS_2	4.0*	3.0–7.0	4.0*	1.0–8.0
PS_3	4.0*	3.0–6.0	4.5*	2.0–6.0
CAL (mm)				
Baseline	4.3	4.0–7.0	4.0	4.0–7.0
PS_1	1.5*	1.0–3.0	1.5*	1.0–3.0
PS_2	1.5*	1.0–2.5	1.5*	1.0–3.5
PS_3	1.5*	1.0–3.0	1.5*	1.0–4.0
MGJ_L (mm)				
Baseline	5.0	3.0–9.0	5.3	3.0–8.0
PS_1	5.3	2.0–8.0	5.3	1.0–9.0
PS_2	4.5	3.0–7.5	5.0	1.0–9.0
PS_3	4.5	3.0–6.0	5.5	2.0–6.5

*Significantly different compared to baseline ($p<0.01$).

†Significantly different compared to CTG group ($p<0.01$).

CTG, connective tissue graft; PRP, platelet-rich plasma; PS_1, 6 weeks postsurgery; PS_2, 6 months post-surgery; PS_3, 12 months post-surgery; GI, gingival index; PI, plaque index; RD, recession depth; RW, recession width; PD, probing depth; WKT, keratinized tissue width; CAL, clinical attachment level; MGJ_L, localization of mucogingival junction.

Table 3. Root coverage and attachment gain values

	CTG+PRP		RC/AG %	RC (100%)	CTG		RC/AG %	RC (100%)
	median	range			median	range		
RC								
PS_1	3.3	2.5–5.0	88.9	8 (40%)	3.0	2.0–3.5	85.4	9 (45%)
PS_2	3.3	2.0–5.0	88.1	7 (35%)	3.0	2.0–3.5	86.4	9 (45%)
PS_3	3.0	2.0–4.5	86.4	6 (35.3%)	3.0	2.0–3.5	86.4	8 (42.1%)
AG								
PS_1	3.0	1.0–6.0	64.0	N/A	3.0	1.0–5.0	62.7	N/A
PS_2	2.8	1.5–6.0	61.4	N/A	3.0	0.5–5.5	63.5	N/A
PS_3	2.5	1.5–5.5	63.0	N/A	3.0	0.5–4.0	60.4	N/A

CTG, connective tissue graft; PRP, platelet-rich plasma; RC, root coverage; AG, attachment gain; PS_1, 6 weeks post-surgery; PS_2, 6 months post-surgery; PS_3, 12 months post-surgery; N/A, not available.

Table 4. Number of platelets and CEJ–AC values

	Platelet/mm^3 (CBC)		Platelet/mm^3 (PRP)		CEJ-AC (mm)	
	median	range	median	range	median	range
CTG+PRP	173,000	135,000–328,000	768,500	535,000–1,224,000	6	5–9
CTG	N/A	N/A	N/A	N/A	6	5–8

CTG, connective tissue graft; PRP, platelet-rich plasma; CEJ–AC, distance between cemento-enamel junction and alveolar crest; N/A, not available.

results, controlled clinical trials could not document any additional benefits of the gel in RC and AG. Huang et al. (2005) reported in their controlled study that the CPF–PRP combination did not present any different results compared with CPF (RC: 81%, AG: 58.1%). In a recent study, Jankovic et al. (2007) treated 15 bilateral defects using PRP in conjunction with CTG. In addition to the standard clinical variables they also evaluated the healing events with recordings of healing index and pain intensity, which was performed during the first 7 days and 1, 2 or 3 weeks following surgery. The results of this randomized-controlled study did not reveal any differences between the CTG and CTG+PRP groups in terms of RC and AG. The mean RC and AG percentages at the 6 month follow up were 91.7% and 70.6%, respectively. Their results were almost in accordance with the results of the CTG+PRP group in the present study, showing that the mean RC achieved at 6 months was 88.1% and AG was 61.4%. Owing to the absence of any published literature demonstrating 1-year follow-up results of the platelet gel application in periodontal plastic surgery, we are not able to compare ours results.

WKT has been considered to be critical for maintenance of gingival health. In the present study, significant increases in WKT were observed in all periods compared with the BL values for both the study groups, and the results were in agreement with several studies involving the incorporation of CTG (Zucchelli et al. 1998, Caffesse et al. 2000), a CPF+platelet concentrate graft (Cheung & Griffin 2004), CPF+PRP (Huang et al. 2005) and CTG+PRP (Jankovic et al. 2007). In the present study, PRP did not provide an saddditional benefit to CTG in terms of WKT at the 6 and 12-month follow up. On the contrary, Jankovic et al. (2007) recorded significantly higher WKT gain at 6 months following surgery by combining PRP with the CTG procedure and linked their results to the possible tissue manifestation of the proliferation of gingival or periodontal fibroblasts as a result of the influence of growth factors from PRP. Therefore, further studies are still needed to clarify the effect of PRP on WKT gain when utilized with CTG.

The distance from CEJ to AC in the CTG+PRP and CTG groups was not statistically different (Table 4). Correlation analysis evaluating the influence of CEJ–AC on the therapeutic outcome variables revealed that the level of AC at the beginning of the study was a negative efficient factor for RC only in the control group (Table 5). However, the level of alveolar bone did not give rise to any difference between both treatment modalities in terms of RC and AG (Table 2).

In the present study, a full-thickness flap was raised in the PRP applied group to obtain better contact between the platelet gel and the alveolar bone enclosing the recession defect. On the contrary, a partial-thickness flap procedure was used in the CTG group as

Table 5. Correlation coefficient r_s of the correlations between platelet number increase, CEJ-AC, root coverage and attachment gain percentages

	r_s	PRP/CBC	CEJ-AC	RC% PS_1	RC% PS_2	RC% PS_3	AG% PS_1	AG% PS_2	AG% PS_3
CTG+PRP	PRP/CBC	1	0.144	0.230	0.304	0.239	0.131	−0.022	0.143
	CEJ-AC	0.144	1	−0.101	−0.009	0.144	0.273	0.244	0.329
CTG	CEJ-AC	N/A	1	−0.575**	−0.457*	−0.613**	−0.408	−0.263	−0.431

*Correlation is significant at the 0.05 level.
**Correlation is significant at the 0.01 level.
PRP, platelet-rich plasma; PRP/CBC, platelet number increase; CEJ-AC, distance from cemento-enamel junction to alveolar crest; RC, root coverage; AG, attachment gain; PS_1, 6 weeks postsurgery; PS_2, 6 months post-surgery; PS_3, 12 months post-surgery; CTG, connective tissue graft; N/A, not available.

suggested by many authors (Borghetti et al. 1999, Paolantonio 2002). Although the different flap thickness may hide results due to the use of PRP only, in the present study two methods were compared as unique treatment modalities. When the CTG technique using a partial-thickness flap was compared with the full-thickness flap in combination with PRP, similar clinical results were obtained.

In the present study, the average PRP production per 8 ml whole blood was 0.7–0.8 ml and increased the platelet concentration approximately four times in mm^3 blood (Table 4). This technique of producing PRP was introduced by Weibrich et al. (2001) and contributed to the same volume of gel and platelet concentrations similar to the previous reports (Marx et al. 1998, Weibrich et al. 2002). Recent advances in PRP technology were able to provide more consistent platelet concentrations than those observed in our study. However, no dose–dependent effect of PRP and growth factors on periodontal regeneration outcomes could be detected (Christgau et al. 2006). Correlation analysis of the present randomized trial also supported this knowledge by not demonstrating any relationship between platelet increase and the outcome variables of RC and AG (Table 5).

In the present study, surgical procedures have not been performed in the same patient according to the ''split-mouth'' protocol. In addition, the different surgical protocols utilized in the two study groups and the limited number of patients can be considered to be the limitations of this controlled clinical study.

Conclusion

Overall the 12-month findings of the present study suggest that the treatment of gingival recession with CTG or a CTG–PRP combination results in favourable clinical outcomes. However, only a few clinical differences that failed to reach a statistical value in favour of CTG or a CTG–PRP combination were found. Whether much longer follow-up studies with higher statistical power may change these results remains questionable. In addition, PRP preparation may increase the surgical time compared with the CTG technique during the CTG+PRP procedure because it appears to be difficult to handle the platelet gel properly and place it in a fixed position on the recipient bone and root area.

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Clinical Relevance

Scientific rationale for the study: This 1-year follow-up randomized-controlled clinical study aims to compare the results obtained by CTG or CTG+PRP in the treatment of gingival recession and to investigate the influence of platelet number increase and the level of alveolar bone to the RC and AG.

Principal findings: Detectable statistically significant difference of any clinical variables, except RW, between the two groups (CTG+PRP and CTG) was not found.

Practical implications: No difference could be found between CTG and CTG–PRP procedures in gingival recession therapy. Whether much longer follow-up studies with higher statistical power may change these results remains questionable.