Comparison of the Palatal Connective Tissue Graft as a Membrane with Collagen Membrane in Combination with Bio-Oss and PRGF for Treatment of Intrabony Defects: A Randomized Clinical Trial

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Abstract

Objective: This randomized clinical trial aimed at comparing the outcomes of palatal connective tissue membrane+ Bio-Oss+ PRGF versus collagen membrane+ Bio-Oss+ PRGF for treatment of intrabony defects.

Methods: Fifteen patients with chronic periodontitis were enrolled. Each patient had at least 2 intrabony defects (≥3mm). They were randomly assigned into 2 groups: patients treated I: with collagen membrane+ PRGF+ Bio-Oss (control group) and II: with palatal connective tissue as membrane+ PRGF+ Bio-Oss (experimental group). Clinical and intrasurgical examinations included probing depth (PD), clinical attachment level (CAL), gingival recession (GR), defect fill (DF), alveolar crest level (AC) and defect resolution (DR) which were measured at baseline and after 6 months with re-entry surgery. Statistical analysis was performed using Two-way Repeated Measure ANOVA and Wilcoxon signed-rank test.

Results: After 6 months, all of the evaluated clinical parameters showed statistically significant changes from baseline within each group (P<0.05). The test group showed a significantly smaller amount of gingival recession as compared with control group (0.8 mm versus 1.7 mm, respectively; P<0.05). But there were no statistically significant differences in other clinical parameters between the test and control groups (P>0.05) like pocket depth reduction (3.7 mm versus 3.5 mm), clinical attachment gain (1.8 mm versus 1.6 mm), alveolar crest loss (1.8 mm versus 1.7 mm), defect fill (2.3 mm versus 2.2 mm) and defect resolution (4.1 mm versus 3.9 mm).

Conclusion: According to the results obtained from this study it can be concluded that clinical effects of application of palatal connective tissue as a membrane and collagen membrane in combination with Bio-Oss and PRGF in treatment of vertical bone defects did not have any statistically significant differences except for gingival recession that was significantly smaller in connective tissue group.

Key words: GTR, Intrabony defect, Bio-Oss, PRGF, Palatal connective tissue graft

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Introduction:

The goal of periodontal treatments is to prevent further destruction of tissues and reconstruction and regeneration of periodontal tissues damaged due to disease or trauma in a way that these tissues regain their lost structure and function. A successful periodontal regeneration includes regeneration of cementum, alveolar bone, periodontal ligament and connective tissue fibers attached to the root surface (1). There is a belief that the main factor that prevents periodontal tissue regeneration after conventional treatments is the faster migration of epithelial cells into the lesion compared to the mesenchymal cells (2) which results in a formation of a long junctional epithelium and prevents a new periodontal attachment to the root surface (3). On the other
hand, occupying the defect space by gingival connective tissue is not favorable either because attachment of the connective tissue to the root surface will cause root absorption (4). Therefore, the aim of regenerative treatment is to prevent the migration of epithelial and connective tissue cells into the lesion and saving the space inside the defect for proliferation of a specific population of cells in order to form a new periodontal attachment. That is why this treatment modality is called Guided Tissue Regeneration (GTR)(1). The biologic basis of GTR is the hypothesis of preventing the migration of epithelial and connective tissue cells of the flap into the defect by placing a physical barrier. This way periodontal ligament cells and mesenchymal cells will get the chance to migrate to the root surface (5). According to the histological findings, GTR is the most predictable regenerative method for reconstruction and regeneration of bone and cementum (6).

In order to create this physical barrier various materials like Methyl cellulose acetate, expanded polytetrafluoroethylene (ePTFE), collagen, autogenous membranes, polyglycoside synthetic polymers or calcium sulfate have been used (7). Collagen membranes are absorbable and made of Bovine or porcine type I collagen. Bio-Gide is one of these membranes with a porcine origin (4). Palatal connective tissue is an autogenous membrane (8). Available literature regarding the application of connective tissue as a membrane is scarce but most of them have shown that connective tissue can be used as a membrane.

Sometimes, graft materials are also used below the membrane with the aim of helping to maintain the space below the membrane and use of their osteoconductive or osteoinductive properties (9). Bovine porous bone mineral (BPBM) like Bio-Oss is among these materials. This material is extensively used in the process of periodontal regeneration (10).

On the other hand, it has been determined that growth factors play an important role in the process of repair and tissue regeneration. Platelets are a rich source of these growth factors. Platelets play a significant role in blood clot formation. When a wound occurs, this is the blood clot that initiates the process of repair because by activation and degranulation of platelets, growth factors are released in the affected area. Platelets comprise about 5% of a blood clot but by using special techniques we can increase this rate up to 95%. One of these techniques is to produce Plasma Rich in Growth Factor (PRGF) through using patient’s own blood (11-14).

To date, numerous studies have been conducted to evaluate the effect of platelet rich plasma on the outcome of periodontal regenerative treatments. But no study has ever evaluated the effect of adding it to GTR treatment when using palatal connective tissue as a membrane; although the similar function of palatal connective tissue membrane and collagen membrane has been demonstrated in GTR technique (15). This study aimed at comparing the clinical outcome of using palatal connective tissue membrane+ PRGF+ Bio-Oss (case group) with application of collagen membrane+ PRGF+ Bio-Oss (control group) in patients presenting to the Periodontics Department of Shahid Beheshti Medical University, School of Dentistry.

**Methods:**

This randomized controlled clinical trial was performed on 30 alveolar vertical intrabony defects of 15 patients (9 females and 6 males) suffering from moderate to advanced chronic periodontitis with a mean age of 35.5±3.64 yrs. Each patient should have at least 2 interdental, 2 or 3-wall vertical defects in the alveolar bone with a minimum probing depth of 6 mm after the first phase of treatment and defect depth of 3 mm at baseline. In each patient, one defect was randomly selected as the case and the other one as the control sample. Patients who had good cooperation in terms of hygiene control and had plaque index of ≤20% were entered the study. The Patients would be excluded from the study if they met any of the following exclusion criteria: presence of systemic diseases, pregnancy or nursing, patients with inappropriate plaque control, grade III mobility, having other types of periodontitis except for
chronic periodontitis, history of periodontal surgery within the previous 6 months, history of using antibiotics in the last 3 months and if during the surgery the defect would be diagnosed as a single-wall defect. After informing patients about the study and obtaining their consent, an acrylic stent (Ivoclar, Germany) was fabricated in a way that it would cover up all the teeth in one jaw (based on the location of lesion) in order to record the understudy variables. For ensuring the complete insertion of the stent, we measured the distance between the stent and CEJ (in a tooth with exposed CEJ) or the distance of stent from a filling. Some slots were made on the stent at the site of lesion to place the probe. Before initiation of the surgical phase, patients were first received oral hygiene instructions and for assessment of their oral hygiene Simplified Debris Index (DI-S) (16) was used. In order to match the oral hygiene in all subjects, if the total plaque index for the full mouth was equal or lower than 20% and the DI-S was not greater than 1 at the surgical site, the patient would enter the surgical phase. Otherwise, and if the patient was not cooperative, the patient would be excluded from the study. After giving oral hygiene instructions, scaling and root planning were performed during 2 sessions with 2 weeks interval and then for hygiene control, patients were reevaluated at 2 weeks periods. If the patients had signs of traumatic occlusion, occlusal adjustment would be performed for them. These periodic examinations were continued for 6 weeks. After 6 weeks, if some other parts also needed surgery, such surgeries would be performed first and then the surgery of the respective area would be performed. After 6 weeks, right before the surgical phase, soft tissue parameters including pocket depth, clinical attachment level (distance between the lower margin of stent and the probing depth) and distance of the lower border of stent and gingival margin at the respective tooth were recorded. For the mentioned measurements, pressure sensitive periodontal probe was used. All measurements were performed by one investigator and all the surgeries were done by one surgeon.

Preparation of Plasma Rich in Growth Factor (PRGF): A few minutes before the surgery, 10-20 ml blood was taken from patients and poured into 5 ml test tubes containing sodium citrate 3.8%. Sodium citrate prevents coagulation. These tubes were then centrifuged using a digital device (PRGF system, Biotechnology Institute, Spain) which had variable time and speed parameters. The required speed for separation of plasma was 460 g for 8 minutes. By doing so, blood was divided into 3 layers: the bottom layer contained red blood cells, the middle layer was PRGF (plasma rich in growth factor) and the superficial layer was PPGF (plasma poor in growth factor). One ml was taken from the upper layer of every tube which contained PPGF by a pipette and was discarded. The remaining plasma which was about 1 ml was taken by a pipette and poured in a special sterile tray and 50 µl calcium chloride 10% for activation of platelets was added to the tray. After 5-7 minutes at room temperature or 2-3 minutes at 37 °C a gelatinous substance was formed that was ready to use.

Surgical technique: after local anesthesia induction with xylocaine 2% along with epinephrine 1/80,000 (Daroo Pakhsh, Iran) at both sides, sulcular incision was made with scalpel #15 (Aesculap, Malaysia) within the dimensions of one tooth at mesial and distal of the lesion in buccal and lingual surfaces. Then a mucoperiosteal flap was raised using periosteal elevator over the defect with a 3 mm margin. After complete excision of the granulation tissue, root planning was performed for root surface using hand instruments (Hue-Friedy, USA). The internal surface of the flap was also freed from the granulation tissue and pocket epithelium at buccal and lingual using a curette. In order to reposition the flaps coronally, they were undermined and the periosteum present in the apical and lateral side of the buccal flap was incised. The stent was then placed and after ensuring its correct and complete positioning, hard tissue parameters such as the distance of the defect depth and alveolar crest from the stent and distance of the alveolar crest from the defect depth were measured using a probe. Number of defect walls was also recorded. These measurements were performed for both cases and control lesions. Then, 0.25-1 mm Bio-Oss granules (Geistlich) were mixed with coagulated
PRGF and placed inside the defect and filled it up to its margins but did not overfill it. In the experimental group, palatal connective tissue was used as a membrane for covering the lesion and the graft material. In order to harvest palatal connective tissue, after induction of local anesthesia, a horizontal incision was made with 3 mm distance from the palatal gingival margin with 1 mm depth between the first premolar and first molar (based on the required vertical and transverse dimensions for covering the lesion and a 3 mm margin of the surrounding bone) using a #15 scalpel. Then, 2 vertical incisions were made starting from the margins of the horizontal incision towards the palatal midline. The mucosal flap was reflected and fixed away from the underlying tissue using 3-0 silk sutures (Supa, Iran). The underlying connective tissue was separated via sharp dissection with a mean thickness of 1.5 -2 mm without removing the periosteum. Adipose tissue of its inferior surface was also dissected. Palatal flap was sutured back to its original position. The harvested connective tissue of its inferior surface was also dissected. Palatal flap was sutured back to its original position. The harvested connective tissue was placed over the lesion in a way that it completely covered the defect and a 3 mm margin. In order to fix the connective tissue cross horizontal mattress suture was applied using 4-0 silk sutures. The needle was entered from the distobuccal corner of the external surface of flap with 3-4 mm distance apical to the connective tissue, passed through the flap and exited from the mesiolingual corner of the lingual flap. Then it traversed the lesion horizontally and entered from the external surface of the lingual flap from its distopalatal corner (lingual), traversed the connective tissue and exited the internal surface of the buccal flap at mesiobuccal corner with the mentioned distance. Eventually the knot was tightened at the distobuccal corner (without passing through the connective tissue). At the end, coronal margins of the flap were sutured using interrupted sutures (4-0 silk). These borders had been placed coronally and were sutured in a way to maintain that position. In the control group, Bio-Gide collagen membrane was used instead of connective tissue. It completely covered the lesion and at least 3mm of the surrounding bone and perfectly matched the area of defect. For fixing the membrane, sutures were applied as above. The flap was prepared to be positioned coronally and was sutured in a coronally position. In both groups, surgical dressing was placed on the surgical site at the end of the operation (Regular, Coe-Pak GC America INC).

Post-operative care: For both groups, amoxicillin 500 mg was prescribed every 8 hours 3 times daily for one week. For analgesia, ibuprofen 400 mg was prescribed every 4 hours. Patients were advised to use ice pack over the area to decrease post-op swelling and use soft foods. Also, chlorhexidine mouthwash 0.2% was prescribed twice daily for one month after surgery. Patients had a follow up visit 10 days later for removing the sutures and the dressing. During the next one month, full mouth polishing was performed for all patients every 2 weeks. Then, they were followed up monthly up to 6 months post operatively. After six months, surgical re-entry was performed.

Surgical re-entry 6 months later than the first surgery: Before surgery, stent was placed and all soft tissue parameters were measured. After induction of anesthesia, sulcular incision was made within the dimensions of one tooth at mesial and distal of the lesion. A mucoperiosteal flap was reflected in order to disclose the bony defect. Stent was placed in the area and hard tissue parameters were also evaluated. Then, based on the amount of defect remaining, the required treatment was performed. At the end, flap was sutured back using interrupted sutures (4-0silk) and was covered with surgical dressing. The above mentioned phases were similar in both groups. One week later, the patients were visited again to remove the dressing and sutures. Chlorhexidine mouthwash 0.2% was prescribed for the patients twice daily for one week. Collected data were analyzed using SPSS version 16 software and changes of the mentioned variables were assessed. Normal distribution of variables was evaluated using Kolmogorov-Smirnov test. Since gingival recession had a normal distribution, Two-Way Repeated Measure ANOVA was used for this variable. For other variables however, since their distribution was not normal, Wilcoxon rank test was used.
Figure 1- Comparison of clinical and radiographic appearance before and 6 months after treatment in the connective tissue group

Figure 2- Comparison of clinical and radiographic appearance before and 6 months after treatment in the collagen group
Results:

Results demonstrated that pocket depth reduction was 3.5±0.9 mm in the control and 3.7±1 mm in the case groups. The 2 groups had no significant difference with each other in terms of the primary pocket depth. After treatment, the difference between the 2 groups in terms of pocket depth reduction was not statistically significant (P>0.05). But within each group a significant difference was detected in terms of pocket depth reduction after treatment with baseline values (P<0.05)(Figure 1).

![Figure 1- Pocket depth reduction in each group following treatment](Image)

Clinical attachment gain in both groups was statistically significant (compared to the baseline values)(P<0.05). This rate was 1.8±0.7 mm in the case and 1.6±0.7 mm in the control groups. The difference between the 2 groups however was not significant (P>0.05, Figure 2).

![Figure 2- Clinical attachment gain in both groups post-operatively](Image)

Gingival recession was 0.8±0.6 mm in the case and 1.7±0.7 mm in the control groups. The baseline value of gingival position was not significantly different between the 2 groups (P>0.05). However, after treatment this difference was statistically significant (P<0.05). In other words, gingival recession in the case group was significantly smaller than the control group (Figure 3).

![Figure 3- Gingival recession value in each group after treatment](Image)

Alveolar crest loss was 1.8±0.8 mm in the case group which was significantly different from its baseline value (P<0.05). In the control group, this rate was 1.7±0.7 mm which was also significantly different from the baseline value (P<0.05). The difference between the 2 groups in terms of alveolar crest loss was not statistically significant (P>0.05, Figure 4).

![Figure 4- Alveolar crest loss in each group after treatment](Image)

Defect depth was not significantly different between the 2 groups pre-operatively. Defect fill was 2.3±1.3 mm in the case and 2.2±0.6 mm in the control groups which was significantly different from the baseline values in both groups (P<0.05). However, the difference between the 2 groups was not statistically significant post..
operatively (P>0.05). Defect resolution after treatment was 75.9±20.3% in the case and 76.4±21.5% in the control groups. The changes in both groups were significant compared to the baseline values but the difference between the 2 groups was not statistically significant (P>0.05). The mean defect resolution was 1.4±1.1 mm in the case and 3.9±1.1 mm in the control group (Figure 5). Changes in the understudy indices are summarized in Table 1.

Figure 5- Defect fill after treatment in each group

| Table 1- Changes in the measured indices before and 6 months after treatment |
|----------------|----------------|----------------|----------------|
|                | Case group      | Control group  | Result         |
|                | N=15, X±SD      | N=15, X±SD     |                |
| Pocket depth reduction | 3.7±1           | 3.5±0.9        | Non significant|
| Gingival recession     | 0.8±0.6         | 0.8±0.6        | Significant    |
| Clinical attachment gain | 1.8±0.7       | 1.8±0.7        | Non significant|
| Alveolar crest loss   | 1.8±0.8         | 1.8±0.8        | Non significant|
| Defect fill            | 2.3±1.3         | 2.3±1.3        | Non significant|
| Defect resolution      | 4.1±1.1         | 4.1±1.1        | Non significant|

Discussion:

This study was designed to compare the clinical outcome of 2 regenerative surgical methods (palatal connective tissue as a membrane+ Bio-Oss+ PRGF in the case group and collagen membrane+ Bio-Oss+ PRGF in the control group) for treatment of intrabony defects of the alveolar bone. Study results demonstrated that both methods are efficient in terms of improving the clinical parameters. Pocket depth reduction was 3.7±1 mm in the case (connective tissue) group and 3.5±1 mm in the control (collagen) group. The difference in both groups compared to the baseline values was statistically significant. Clinical attachment gain was 1.8±0.7 mm in the connective tissue group and 1.6±0.7 mm in the collagen group. This difference was
statistically significant in both groups when compared to the baseline values. Defect fill was 2.3±1.3 mm in the connective tissue and 2.2±0.6 mm in the collagen groups which were also indicative of a significant change when compared to the baseline values. Both methods of using connective tissue and collagen resulted in defect resolution in the amount of 4.1±1.1 mm and 3.9±1.1, respectively which were statistically significant compared to the baseline values. Statistical analysis showed that both methods had similar efficacy in improving the measured clinical indices (Pocket depth reduction, clinical attachment gain, defect fill, and defect resolution) and no significant difference was detected between the 2 groups.

Alveolar crest loss was 1.8±0.8 mm in the connective tissue and 1.7±0.7 mm in the collagen group which were significantly different than the baseline values in both groups. However, this difference between the 2 groups was not statistically significant. The only variable that was significantly different between the 2 groups was gingival recession rate which in the connective tissue group was half the rate in the collagen group (0.8±0.6 mm versus 1.7±0.7 mm). In a study by Moghaddas and Soltani (2004)(15) palatal connective tissue along with Bio-Oss was used in the case and collagen membrane along with Bio-Oss was used in the control group. All phases of their study were similar to ours. The only difference between the 2 was in the use of PRGF in the present study. The obtained figures regarding gingival recession rate, clinical attachment gain, defect fill and defect resolution in the case groups of the 2 studies were similar (0.9, 1.5, 3.4 and 3.9 in Moghaddas and Soltani study versus 0.8, 3.8, 2.1 and 4.1 in the present study, respectively). Therefore, it seems that addition of PRGF has not improved the mentioned parameters. However, a significant difference was detected in terms of pocket depth reduction in the case groups of the 2 studies. In the present study, pocket depth reduction was greater than in the Moghaddas and Soltani study (2004)(3.7 versus 2.6 mm, respectively). The greater pocket depth reduction in our study may be due to the application of PRGF. Another difference between the 2 mentioned studies was in alveolar crest loss which was greater in our study compared to the results of Moghaddas and Soltani study (2004) (15) (1.8 versus 0.1, respectively). On the other hand, in the present study gingival recession in the connective tissue group was significantly lower than the collagen group but such difference was not observed in Moghaddas and Soltani study (2004)(15). Lower rate of gingival recession in the connective tissue group in the current study may be justified by the fact that connective tissue was used along with PRGF whereas in Moghaddas and Soltani study (2004) collagen tissue was used alone. However, another study is required to investigate whether the decrease in gingival recession was due to the simultaneous use of connective tissue and PRGF or not.

In a study by Paolantonio et al, in 2010 (17), outcome of 3 methods of debridement flap, debridement flap along with GTR (collagen membrane) and debridement flap along with periosteal connective tissue membrane and graft material (autogenous bone) in treatment of periodontal vertical intrabony defects was evaluated and it was revealed that defect fill was greater in the periosteal connective tissue group than the collagen group (3.1 versus 2.4). For justifying the observed difference, the authors stated that use of graft materials (autogenous bone) in the connective tissue group improved the outcome. They also referred to a systematic review (18) indicating that simultaneous use of membrane and graft material will result in significantly improved bone healing compared to the use of membrane alone. However, in the present study no significant difference was found between the 2 groups in terms of defect fill and it seems that use of autogenous bone below the connective tissue resulted in better filling of intrabony defect in Paolantonio study (2010)(17) which can be attributed to the osteogenic effect of autogenous bone or its role in preventing the membrane from collapsing into the defect. It should be mentioned that re-entry surgery in the current study was performed 6 months after the primary surgery whereas, this time period was 12 months in the Paolantonio study (2010)(17) which might be an effective factor. On the other hand, in Paolantonio study (2010) gingival recession was significantly
smaller in the connective tissue group compared to the collagen group (0.5 versus 2 mm) which can be attributed to the better filling of defect in the periosteal connective tissue group and the effect of this tissue on increasing the gingival thickness. In our study, gingival recession in the connective tissue group was significantly smaller than the collagen group as well although no difference was found in terms of defect fill between the 2 groups. Use of connective tissue along with PRGF may be responsible for smaller gingival recession.

In another study conducted by Kwan et al, in 1998 on the periosteal connective tissue membranes, better results were obtained in the case group (periosteal connective tissue as a membrane) compared to controls (debridement flap alone) in terms of clinical attachment gain (2.3 mm) and defect fill (2.6 mm)(7). In the mentioned study, the author concluded that periosteal connective tissue can be used as a suitable membrane in GTR treatments. He also, attributed the greater defect fill observed in the case group to the osteogenic effects of periosteum because many studies are available that confirm this property. An example of such studies is the one demonstrating that free periosteal grafts harvested from tibia can stimulate osteogenesis in cleft maxilla (19).

It is noteworthy that in all studies conducted on connective tissue membranes, palatal connective tissue along with periosteum has been used and periosteum has been considered as the main component acting as membrane (7, 8). However, in the present study and Moghaddas and Soltani study (2004)(15) palatal connective tissue was harvested through sharp dissection and therefore did not contain the periosteum but still the defect fill was similar to what was reported in other studies. For instance, defect fill in our study was 2.3 mm whereas this rate was 2.6 mm in Kwan study (1998)(7). Another study by Moghaddas and Karimi (1998)(22) is also helpful in this regard. In their study, a mucoperiosteal pedicle flap was used for treatment of alveolar vertical intrabony defects and the results were compared with debridement flap alone. The following results were obtained: 3.5 mm pocket depth reduction, 2.2 mm clinical attachment gain, 1.9 mm smaller gingival recession, alveolar crest loss of 0.3 mm and defect fill in the amount of 2 mm. Our study results are very close to these figures and the only difference is in the rate of alveolar crest loss. This rate in our study was greater than the mentioned study (1.8 versus 0.3, respectively). It is worth noting that alveolar crest loss in our study was greater than the rate mentioned in Moghaddas and Soltani (2004)(15), Moghaddas and Karimi (198)(22) and Kwan (1998)(7) studies. In Moghaddas and Karimi study (1998)(22) and Kwan study (1998)(7) periosteal connective tissue was used but we used connective tissue without the periosteum in our study which is similar to what was used in Moghaddas and Soltani study (2004)(15). Therefore, it seems that higher rate of alveolar crest loss in our study may be due to the anatomical differences of the bony defects and especially thickness of the crestal bone (23).

Considering all the above, it looks like connective tissue alone can also work as a suitable physical barrier in GTR treatments. However, in order to find out if periosteum can improve the outcome or considering its osteogenic effects, can result in better defect fill, a similar study is required to compare the outcome of using palatal connective tissue with and without periosteum.

It has been stated that proliferation of the membrane harvested from the palatal connective tissue into the defect is unlikely (7). Therefore, it can very well play the role of a biologic membrane than can be well tolerated in the body (7). The studies conducted in this respect (7, 8, 15, 21) indicate that palatal connective tissue along with periosteum can be used as a suitable membrane in regenerative treatments because it is can be easily harvested and does not need a second surgery for removal. There is no risk of disease transmission, it is well tolerated by the body and if exposed into the oral cavity does not compromise the treatment outcome (7).
Based on the study results, it can be concluded that palatal connective tissue without periosteum can also be used as a membrane in GTR treatments because in terms of clinical indices it was similar to the collagen membrane. However, confirming the actual entity of periodontal tissue regenerations whether due to the collagen or connective tissue membranes is only possible through histologic evaluations which are usually not feasible in human studies.

Smaller gingival recession in the connective tissue group can be a great advantage for this membrane because esthetic considerations are an important reason for using regenerative treatment modalities and the smaller the amount of gingival recession especially in the anterior areas, the greater the patient’s satisfaction.

**Conclusion:**

The obtained results demonstrated that outcome of application of palatal connective tissue as a membrane+ Bio-Oss+ PRGF was not significantly different from using collagen membrane+ PRGF+ Bio-Oss in terms of pocket depth reduction, defect fill, alveolar crest loss, clinical attachment gain, and defect resolution. The only difference detected was smaller gingival recession in the connective tissue group.

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