Use of a Bone Regeneration Cement for the Management of Gingival Margin in Tooth Extraction Areas

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_Abstract

The procedures for guided bone regeneration (GBR) in tooth extraction areas favour the maintenance of anatomical contours and increase the predictability of aesthetic success. Nevertheless, the complex handling of the flap associated with these techniques can compromise the aesthetic and functional results. Aiming at better and more predictable results the use of an injectable calcium phosphate cement is suggested in this work. A bone regeneration cement called PD VitalOs Cement® (Produits Dentaires SA, Vevey, Switzerland) was used to fill and cover the extraction areas, with or without immediate placement of implants. The technique used does not require the raise of a flap nor an additional surgical site to harvest a graft. Twenty patients divided into two groups were followed up clinically and radiographically. In the test group the patients were treated with PD VitalOs Cement®, whereas the sites of the control group were left empty. The tissues dimensions around the extraction sites were measured up to 90 days after surgery. The results show better management of the buccal gingival margins of the patients treated with PD VitalOs Cement®, which is of prime importance for the final aesthetic results, especially for single-tooth extractions.

_Introduction and Literature Review

Preservation of alveolar margins becomes a critical issue when a tooth is extracted, since the height and width of the margins are major factors influencing the success of the treatment, with implant or with fixed prostheses. The regeneration of buccal bone lost following trauma or disease can bring therapeutic issues in the dental clinic: after a regenerative surgery the osseous defects generally don't heal, or heal with a tissue that differs from the original one, with respect to morphology and function.[1] For instance, the lesions in the alveolar processes heal often with fibrous instead of bony tissue, provoking gingival recession and alteration of the buccal gingival margin.[2] Buccal alveolar bone resorption after tooth extraction results in an important reduction in bone height. The conjunctive tissue can have a strong influence on osteogenesis during alveolar healing, which results in a narrowing of the socket one month after extraction due to local bone resorption. This leads to aesthetic and restorative problems like the decrease of the volume available for implant placement.[3] Guided Bone Regeneration (GBR) is a surgical technique that aims at reducing a bone defect by promoting the formation of new bone. It consists in excluding soft tissues from the bone defect through the use of a barrier allowing only bone cells to be present in the space to be regenerated. This principle is based on the findings of Melcher in 1970,[4] who stated that a type of tissue developing in a given space depends on the type of cells present in the site. The regeneration of periodontal tissues and bone margin using physical barriers is a well-established procedure in reconstructive surgery. However, the characteristics of the biomaterial as well as the design of the barrier membrane have a strong influence on the results.[5] Membranes are used as mechanical barriers protecting the blood clot from the migration of epithelial tissue into this space, thus allowing the selection of bone cells to repopulate the defect.[3] The first membranes for GBR were not resorbable. Therefore, a subsequent surgery was necessary to remove them. These membranes were often

Fig. 1_ Syringe of PD VitalOs Cement®.

Fig. 1

Fig. 2_ Plastic model for measurement of margin recession.

exposed in the oral cavity during the healing phase, which resulted in a significant decrease in bone tissue regeneration,[7–10] consequently jeopardizing the clinical success.[6] The resulting inflammatory reaction requires often early removal of such membranes.[8] Later on, resorbable membranes were developed, based on polymeric materials like collagen, polylactic acid, copolymers of polylactic and polyglycolic acids, or based on minerals like calcium sulfate[11] or calcium phosphate.[12] The most common ones, based on synthetic polymers, degrade through a hydrolysis process, producing chemical substances that are involved in the normal metabolic processes. However, these materials lose their mechanical integrity during hydrolysis and break up into pieces. The quantity and physical nature of fragments can have a significant effect on the local tissue response, leading to bone resorption.[13] The resorption time seems to vary even when primary closure of the wound was achieved. However, depending on the size of the extracted tooth, primary closure is not always achievable, thus leaving the area partially exposed. Membranes must fulfill the following requirements to act as passive physical barriers: they must be biocompatible, possess occlusive properties, be able to create and maintain space and allow tissue integration. In addition to that, they should be easy to handle, affordable and offer predictable success.[14] PD VitalOs Cement (Figure 1) is a ready-to-use resorbable bone regeneration material claimed to act both as a bone filler and as a membrane. This injectable calcium phosphate cement was used in this work to assess its clinical success in GBR procedures after tooth extraction with flapless surgery. The objective of this work was to evaluate the healing and preservation of periodontal tissues after tooth extraction. Sites filled with PD VitalOs Cement were compared to those left empty.

_Material and Methods

Twenty patients requiring tooth extractions were selected for evaluation. The corresponding 23 sites were divided randomly into two groups. In the test group (TG) the extraction sites were filled with PD VitalOs Cement, whereas the sites of the control group (CG) were not filled at all. Among the 20 patients treated, only two did not get immediate implantation because this would have been contra-indicated. They got delayed implantation, with implant placement three months later. To be included in the study the extraction sites had to present a gingival architecture similar to that of the adjacent teeth. Smokers and patients with systemic diseases known as contra-indications for surgery were excluded from the study. The patients were informed about the different treatment options, received detailed information related to the elected treatment as well as its risks and benefits. They all signed an informed consent form before actual inclusion in the study (i.e., before tooth extraction). The mean age of the patients was 39.5 years, with minimum and maximum ages of 28 and 68 years respectively. 65% of the patients were women. The reasons for extraction were the following: vertical root fracture (n = 14), external root resorption (n = 1), extensive caries jeopardizing the biological distance (n = 6), periodontal disease (horizontal bone loss) with insufficient bone to support a prosthetic crown (n = 2) (Table 1). After extraction, the remaining alveolar walls situation was carefully evaluated and only type 1 sites (classification of Salama and Salama)[15] were actually included in the study (Table 1).

The implants used were cylindrical, with diameters matching as much as possible the root diameter of the extracted teeth,[16] to make sure that the platform

Etiology	Nr. of sites	Percentage
Vertical root fracture	14	61%
Extensive caries	6	26%
Periodontal disease	2	8.5%
Root resorption	1	4.5%
TOTAL	23	100%

Table 1_ Etiology of the extraction cases.

Fig. 3a_ Pre-op situation.
Fig. 3b_ Placement of implants and PD VitalOs Cement.
Fig. 3c_ Suture.

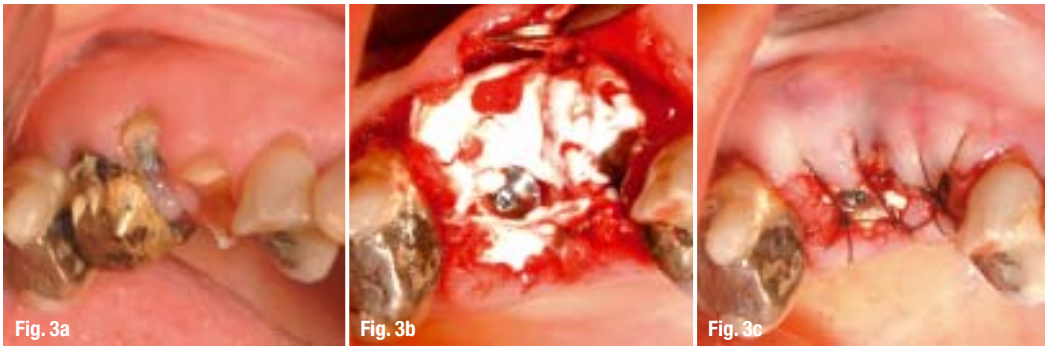

Table 2 _ Gingival margin recession in the Control Group (CG).

Pat. Nr.	Tooth Nr.	MW (pre-Op)	MW (7 days)	MW (30 days)	MW (90 days)	Margin Recession MR (90 days)
CG 1	16	12.0	12.0	11.0	9.5	2.5
CG 2	24	9.5	9.0	9.0	8.0	1.5
CG 3	25	10.5	10.0	9.5	9.0	1.5
CG 4	14	11.0	10.5	10.0	9.0	2.0
CG 5	11	8.5	8.5	8.0	7.7	1.0
CG 6	12	7.5	7.0	7.0	6.0	1.5
CG 7	21	9.0	8.5	8.5	8.0	1.0
CG 8	22	8.5	8.0	8.0	7.5	1.0
CG 9	46	12.0	11.0	10.5	10.0	2.0
CG 10	13	10.0	9.5	9.0	8.0	2.0

MW–Margin Width (mm),
MR–Margin Recession (mm) = MW (X days) – MW (pre-op)

diameter is slightly smaller than the diameter of the alveolus and to provide a minimum distance of 2 mm between the implant and the neighboring tooth.[17]

_Clinical, radiographic and laboratory evaluation

The cases were evaluated clinically, radiographically (periapical radiographs) and in the laboratory (measurement of plaster models). These evaluations took place pre-operatively and 7, 30 and 90 days after tooth extraction. The margin widths on the plaster models were measured with a Starrett® caliper in the bucco-lingual direction at the mid-point of the extraction site. For each patient, a plastic guide was molded on the pre-op plaster model. It was then placed onto the post-operative models to ensure precise and reproducible measurement location for assessment of margin recession (Fig. 2). Periapical radiographs extended between the mesial and distal edges of the extracted root and allowed assessment of marginal bone resorption. One case of the Test Group is shown in Figure 3: extraction of two teeth, placement of two implants and defect filling with PD VitalOs Cement. Figure 4 shows one case of the Control Group: extraction of a molar, placement of implant and suture without filling the bone defect.

_Results

PD VitalOs Cement was very easy to apply into the post-extraction bone defects. The tip of the syringe allows fast and accurate product injection. The defects were always completely filled, up to the margin level. Data collection is still on-going and more results will be published with a longer follow-up period. The radiographs have confirmed usual clinical findings and showed vertical bone loss in the usual range[18] (almost 2 mm), with slightly more loss in the control group. The mean buccal margin recession was assessed through measurements of models made at each follow-up step (Tables 2 and 3, Graph 1). The measurements under 0.25 mm were rounded down to zero and those between 0.26 and 0.49 were rounded up to 0.5 mm. The mean gingival margin recession at 90 days after surgery was 1.6 mm in the control group and 0.4 mm in the test group. In the control group, one site presented a recession of 2.5 mm, three of 2 mm, three of 1.5 mm and three of 1 mm. In the test group, one site showed a recession of 1 mm, ten of 0.5 mm. In two sites, the original anatomical contours were unchanged, which means the dimensions were the same before and after surgery.

_Discussion

Most of the single tooth losses are related to endodontic or periodontal diseases, trauma or root fractures. They can induce resorption of the alveolar bone walls,[19] resulting in a reduction of buccal volume.[2] To minimize this alveolar bone resorption, the placement of an implant immediately after extraction is considered to have the potential to preserve the osseous architecture and the peri-implant gums in a predictable way.[20,21] Recently, new surgical techniques have been developed for immediate

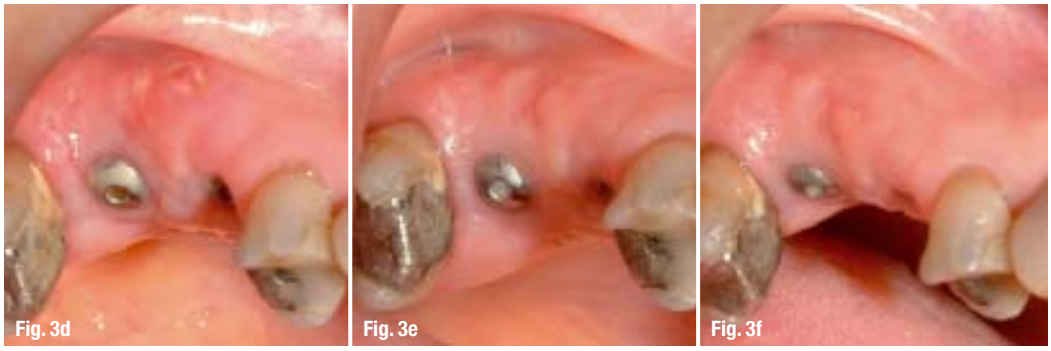
Fig. 3d

Fig. 3e

Fig. 3f

Fig. 3d_ 7 days after surgery.
Fig. 3e_ 30 days after surgery.
Fig. 3f _ 90 days after surgery.

Table 3 _ Gingival margin recession in the Test Group (TG).
Graph 1 _ Distribution of the margin recession for the Test and Control Groups (in mm).

single implant placement. They avoid the raise of flaps and use of membranes and seem to preserve better the gingival architecture, mainly at the level of the interproximal papillae.[22,23,24] However, beyond the knowledge of the surgical techniques to minimize gingival atrophy and papilla height loss, it is necessary to understand the dynamics ruling gingival and bone tissues after implant exposure in the oral cavity as well as their interrelation with the tissues supporting the adjacent teeth.[25] The existence of a biological distance around the implants was evidenced and seems to take place with all types of implants after their exposure.[26] The implants are generally placed close or at the level of the crestal ridge. Once exposed in the oral cavity, the interface between the implant and the healing abutment becomes colonized by bacteria and bone resorption takes place, extending almost 2 mm apically around the implant platform.[19] A biological explanation is that the bone exposed to the oral cavity or close to the union line between implant and abutment (colonized by bacteria) should always be covered by periosteum, conjunctive tissue and epithelium. So, the bone has to resorb to get away from this area chronically exposed and irritated. This way, it ensures that the periosteum, the conjunctive tissue and the sealing provided by the epithelial tissue can form themselves[31] to favour the osseointegration process.[19] It has been shown[28] that at least 2 mm of buccal plate is necessary to avoid that this horizontal component combined with insufficient bone volume lead to a bone dehiscence exposing the implant surface. The loss of support by the peri-implant soft tissues is observed clinically as a margin recession,[2,28] often combined with the observation of a grayish shade under the gingival tissue.[30] A longitudinal study of the behavior of soft peri-implant tissues on the buccal side concluded that, in the first 3 months after implant exposure and healing abutment installation, 80% of the sites showed gingival recession of approximately 0.75 mm. These results suggest that final restorations in aesthetic areas should be placed only after a minimum period of 3 months after implant exposure, i.e. when this anatomical modification has taken place and a stable margin height of the peri-implant tissues is obtained.[31] Var-

Pat. Nr.	Tooth Nr.	MW (pre-0p)	MW (7 days)	MW (30 days)	MW (90 days)	Margin Recession MR (90 days)
TG 1	26	13.0	13.0	12.5	12.5	0.5
TG 2	37	12.0	12.0	11.5	11.5	0.5
TG 3	24	10.0	10.0	10.0	10.0	0
TG 4	15	9.0	9.0	8.5	8.5	0.5
TG 4	16	14.0	14.0	13.0	13.0	1.0
TG 5	12	8.5	8.5	8.0	8.0	0.5
TG 6	11	9.5	9.5	9.5	9.0	0.5
TG 7	21	9.0	9.0	9.0	9.0	0
TG 7	22	8.5	8.5	8.0	8.0	0.5
TG 8	11	10.0	10.0	9.5	9.5	0.5
TG 9	12	9.0	9.0	9.0	8.5	0.5
TG 9	14	9.0	9.0	8.5	8.5	0.5
TG 10	14	9.5	9.5	9.0	9.0	0.5

MW – Margin Width (mm),
MR – Margin Recession (mm) = MW (X days) – MW (pre-op)

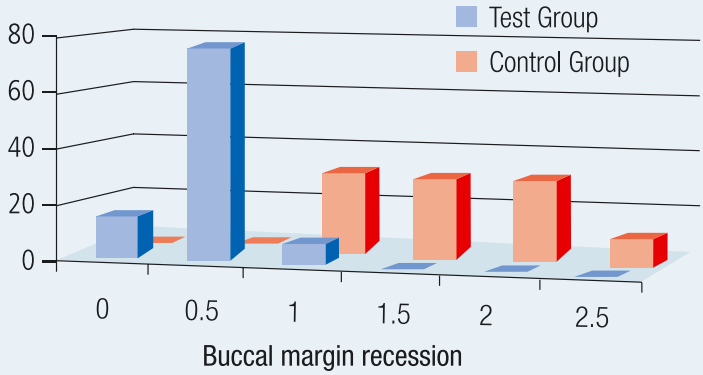

Fig. 4a_ Pre-op situation.
Fig. 4b_ Implant placement.
Fig. 4c_ Suture.

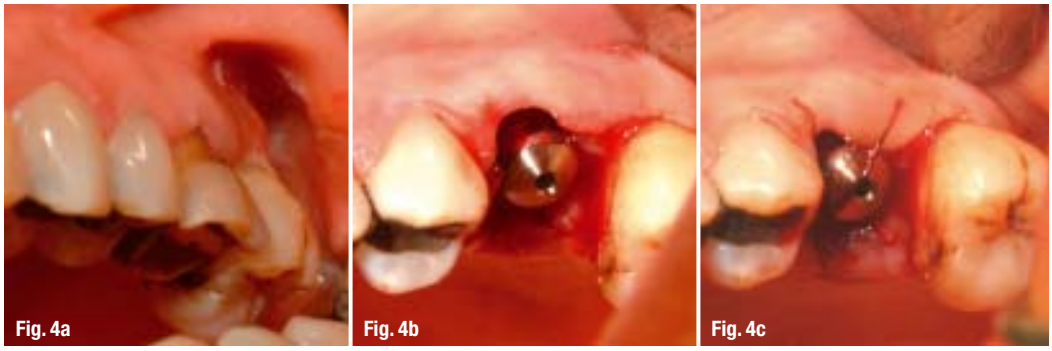
Fig. 4a

Fig. 4b

Fig. 4c

ious studies showed similar mean buccal resorption values after one year: 0.88 mm,[32] 0.6mm[32] and 0.7mm.[29] It is therefore expected that almost 1 mm of buccal gingival margin recession occurs after a surgery of implant exposure and installation of abutment.[31] In the present work, results fairly similar to those of Small and Tarnow[31] were obtained in the Control Group (CG), since 100% of the sites presented buccal gingival margin recession, with a mean resorption value of 1.6 mm compared to the pre-op value. In the test group (TG) the mean value was 0.4 mm, remaining closer to the initial anatomical aspect and measurements. Most of the techniques aiming at preserving sufficient bone height to support the papilla require a second surgical site to harvest a gum graft, which is source of post-operative discomfort for the patient. The use of the injectable PD VitalOs Cement allowed adequate gingival tissue growth on top of the cement although it was left exposed in this work. This allowed maintenance of anatomical peri-implant tissue contours, as was shown through measurement of the buccal margin width. PD VitalOs Cement brings therefore reliable and predictable results for this type of surgery.

_Conclusions

Based on the methodology employed in this work and on the results obtained, we can draw the following conclusions:

1. The use of PD VitalOs Cement associated with careful tooth extraction and implant placement allows preservation of the gingival architecture around an implant during the whole observation period (three months). This ensures a good aesthetic result and facilitates the management of the final restoration.

2. The use of PD VitalOs Cement allows preservation of the gingival margin through minimally invasive single-stage surgery, without flap and without additional surgical site.

3. The cement exposed to the oral cavity was not subject to infection during the whole healing period of the gum.

4. Gingival tissue was found to grow onto the cement surface, preserving this way the interproximal papillae and the gingival free margin.

5. PD VitalOs Cement acts as an efficient barrier to avoid migration of soft tissues into the extraction sites and fills up adequately the treated defects.

6. A mean buccal gingival recession of 1.6 mm was measured after 90 days in the control group, whereas only 0.4 mm recession took place in the sites treated with PD VitalOs Cement._

The literature list can be requested from the author.

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Fig. 4d_ 7 days after surgery.
Fig. 4e_ 30 days after surgery.
Fig. 4f_ 90 days after surgery.

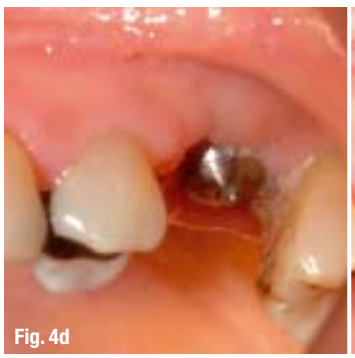
Fig. 4d

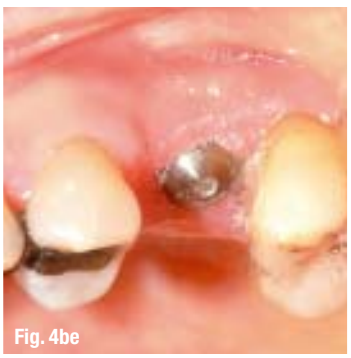
Fig. 4be

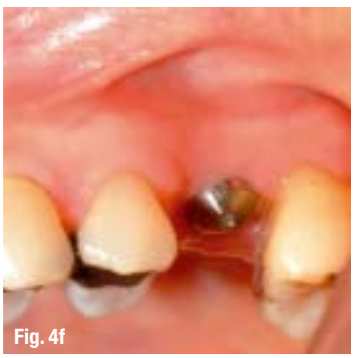
Fig. 4f