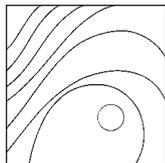


# Extraction Socket Management with Buccal Plate Expansion: Preliminary Results of a Novel Technique



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*The primary objective of this pilot study was to evaluate a new socket preservation technique involving the intentional expansion of the extraction socket buccal plate using a flapless internal corticotomy and biomaterials. A total of 11 patients requiring tooth extraction were enrolled in this study. The aim of this technique was to maintain or improve the hard and soft tissue contour of the ridge after tooth extraction. All surgical sites healed uneventfully. Significant alveolar bone dimension changes were observed in the coronal region of the ridge ( $-1.4 \pm 0.9$  mm); however, it was only slightly lower at the medium ( $-0.35 \pm 0.7$  mm) and apical levels ( $-0.3 \pm 0.8$  mm) ( $P > .05$ ). The ridge dimensional changes were significantly higher in the buccal aspect than in the palatal aspect in all patients. Vertical bone resorption was not significant. Concerning the soft tissue contour, the horizontal distance between the preoperative and postoperative buccal profiles ranged from 0.94 to  $-2.88$  mm. The proposed ridge preservation technique may help maintain the volume of the healed ridge but cannot completely prevent contour changes after tooth extraction.*

Int J Periodontics Restorative Dent 2016;36:e103–e110. doi: 10.11607/prd.2659

Following tooth extraction, marked morphologic and dimensional alterations of the alveolar ridge are observed.<sup>1,2</sup> This resorption is most significant during the first 3 months after tooth extraction and continues for at least 1 year.<sup>3</sup> The average alveolar horizontal and vertical contour reductions are 3.8 mm and 1.8 mm, respectively,<sup>4</sup> and these reductions are primarily due to the resorption of the buccal bone plate.<sup>5</sup> These hard and soft tissue changes may compromise subsequent implant placement and may affect esthetic outcomes due to a lack of tissue volume.

A wide range of extraction socket-management procedures to limit postextraction alveolar bone remodeling have been described.<sup>6</sup> For most of these techniques, biomaterials are used to fill the socket with or without barrier membranes,<sup>7</sup> and several authors have emphasized interest in flapless/atraumatic tooth extraction,<sup>8</sup> immediate implant placement,<sup>9</sup> and primary closure with a coronally advanced flap or by covering the socket with a free gingival graft.<sup>10</sup> According to the literature, these procedures successfully reduce post-extraction bone remodeling;<sup>11,12</sup> however, complete preservation of socket dimensions has not yet been reported.<sup>13</sup> Several authors have suggested alternative treatment strategies to overcome

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the expected bone loss. Some of the proposed techniques have involved a saddle connective tissue graft to thicken the soft tissue and compensate for the expected loss of volume.<sup>14</sup> This technique has displayed excellent outcomes in terms of tissue volume and stability but involves a certain level of morbidity due to the requirement of harvesting soft tissue from the palate. Alternatively, the socket-shield technique has presented effective results for preserving the tissue profile of the implant site.<sup>15</sup> However, indications for this procedural technique are limited and long-term outcomes still need to be investigated. Other authors have described overbuilding procedures to place the graft external to the buccal plate rather than inside the socket.<sup>16,17</sup>

Therefore, the objective of this pilot study was to describe a novel socket-preservation technique involving flapless displacement of the buccal bone plate and the use of biomaterials to compensate for the expected alveolar contour resorption and to assess the efficacy of that technique. Furthermore, hard and soft tissue changes were evaluated and compared with postextraction socket remodeling patterns previously described in the literature.

## Materials and methods

### *Experimental design*

The present study was designed as a case series of 11 patients. Consent was obtained from patients based on the Helsinki Declaration

of 1975, as revised in 2000. All clinical procedures were performed at the Department of Periodontology and Oral Surgery at the University of Liège, Belgium, by two operators (F.L. and G.L.). Informed consent was obtained from all patients prior to performing the surgical procedure.

### *Study population*

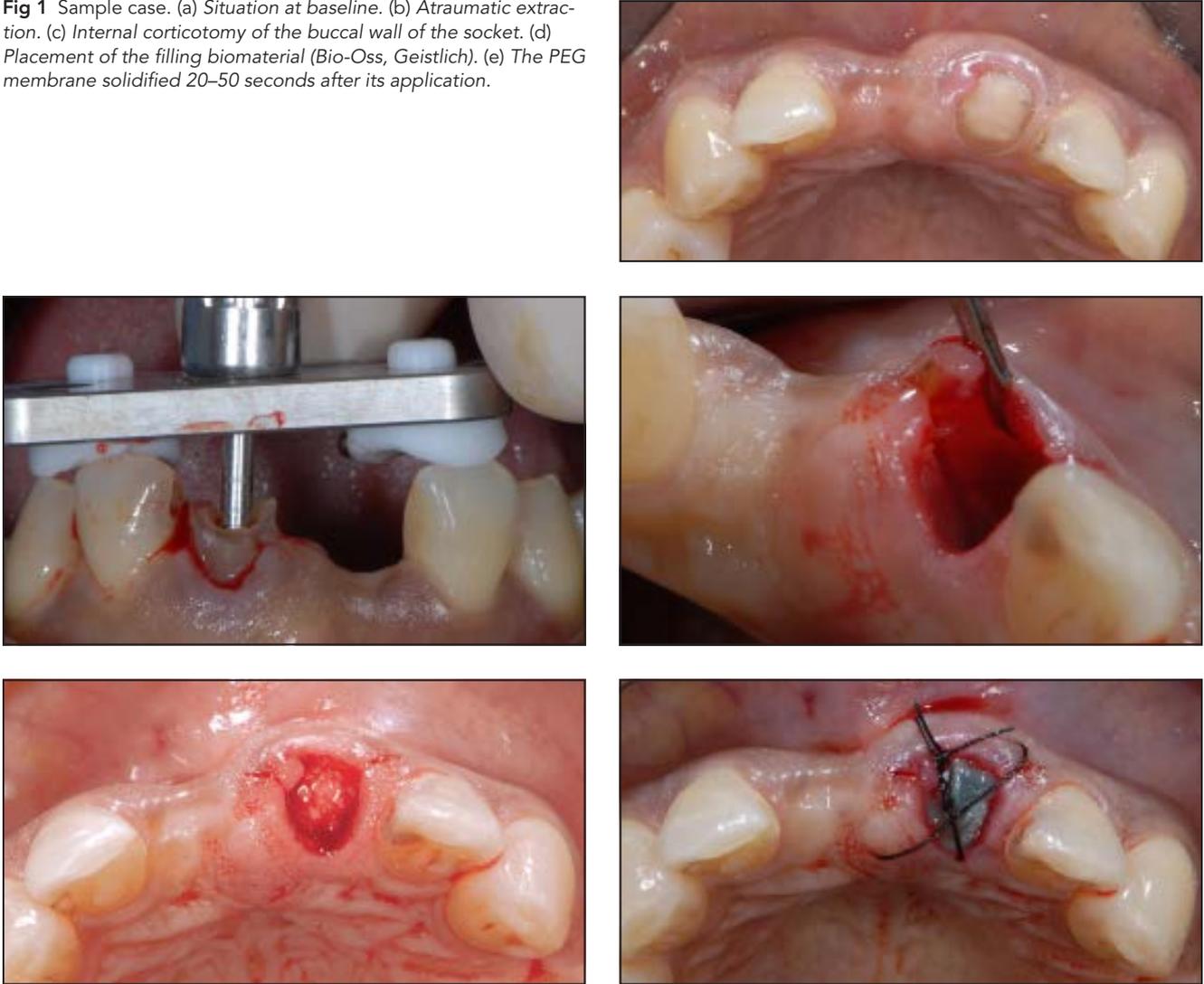
The study population consisted of 11 adult patients requiring tooth extraction in the maxillary anterior teeth and premolars ranging to the second premolar. The included patients were scheduled for extraction due to caries, trauma, or endodontic treatment failures. The patients were enrolled and treated from March 2013 to December 2013. The exclusion criteria included the following: age < 18 years, smoker, presence of relevant medical condition, psychologic disorder, pregnancy or lactation, presence of acute periodontal or periapical pathology, radiotherapy or chemotherapy, and drugs that might compromise bone healing.

Only teeth with an intact buccal bone plate were considered for this procedure. All patients received instructions in oral hygiene and underwent initial periodontal evaluation, including tooth cleaning with scaling, if necessary. The following data were collected for all patients: age, gender, reason for tooth extraction based on both clinical and radiographic examinations, tooth vitality, tooth location, and soft tissue biotype.<sup>18</sup>

### *Surgical procedure*

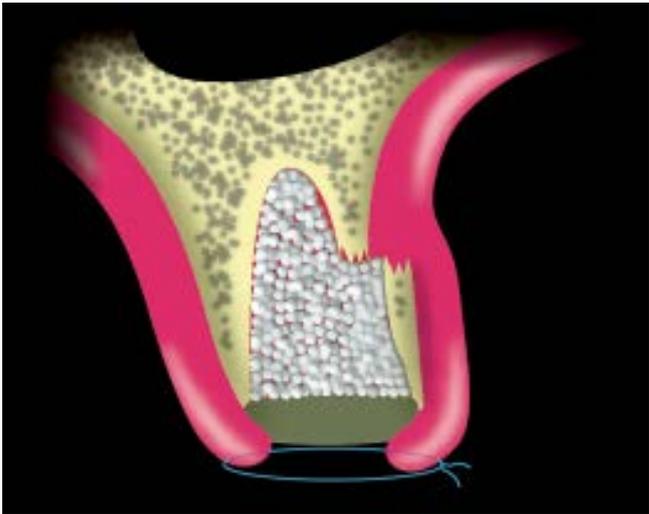
Local anesthesia was administered and the tooth extraction was performed without flap elevation and as atraumatically as possible. The integrity of the buccal plate was evaluated with a probe, and granulation tissues were carefully removed. An internal osteotomy of the socket buccal plate was performed with a Piezotome (Acteon) using the LC2 and BS4 tips of the extraction kit. Two vertical osteotomies and one horizontal osteotomy were made to push the buccal plate outward from the socket. Two small cervical releasing incisions were made in the mesiobuccal and distobuccal aspects of the socket to allow for displacement of the osteotomies in the region of keratinized tissue. The socket was filled with bovine hydroxyapatite (Bio-Oss, Geistlich). The biomaterial was packed to push the released buccal plate outward. A membrane of polyethylene glycol (PEG) (Membragel, Straumann) was used to cover the socket according to the manufacturer's recommendation (Fig 1). The PEG plug was stabilized on the top of the socket with a cross suture (silk 4/0, Sofsilik) (Fig 2). When necessary, a provisional removable partial denture was adjusted without contact to avoid any potential compression of the augmented area during the first week of wound healing.

**Fig 1** Sample case. (a) Situation at baseline. (b) Atraumatic extraction. (c) Internal corticotomy of the buccal wall of the socket. (d) Placement of the filling biomaterial (Bio-Oss, Geistlich). (e) The PEG membrane solidified 20–50 seconds after its application.



*Postoperative instructions and follow-up*

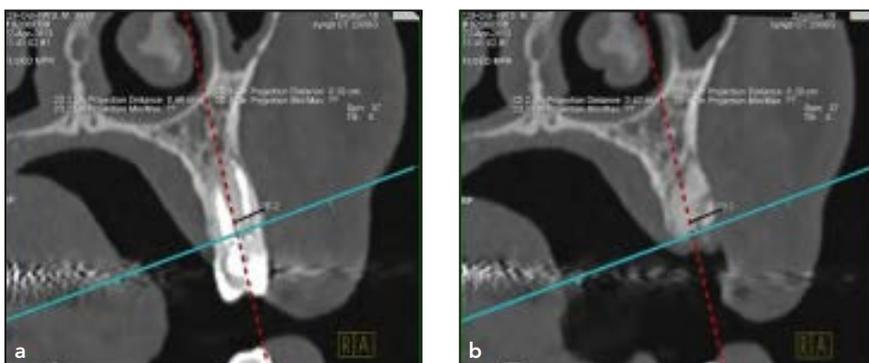
Antibiotics (amoxicillin 500 mg tid) were administered to the patients 1 day before surgery and continued for 5 days. Analgesics (ibuprofen 600 mg) were advised only if necessary. Mouthrinses (chlorhexidine digluconate, Corsodyl) were provided twice a day until suture removal at 10 days after surgery. Patients were instructed not to brush the surgical area until the suture had been removed. Patients attended follow-up visits at 1 month and 3 months after surgery.



**Fig 2** Illustration of the buccal plate expansion technique.



**Fig 3** Situation 3 months post ridge preservation.



**Fig 4** Hard tissue volume analyses at the coronal level (2 mm). (a) Baseline CT scan. (b) CT scan at 3 months postoperative.

### Data collection

#### Patient-centered outcomes

One week after surgery, the patients filled out a visual analog scale (VAS) form to evaluate their level of discomfort and postoperative pain. Drug intake and possible complications were also recorded.

#### Hard and soft tissue analyses

Prior to tooth extraction and 3 months after the surgical procedure (Fig 3), the patients underwent a

cone beam computed tomography (CBCT) (Somatom Emotion, Siemens), and an impression using polyvinyl siloxane (Express 2, 3M ESPE).

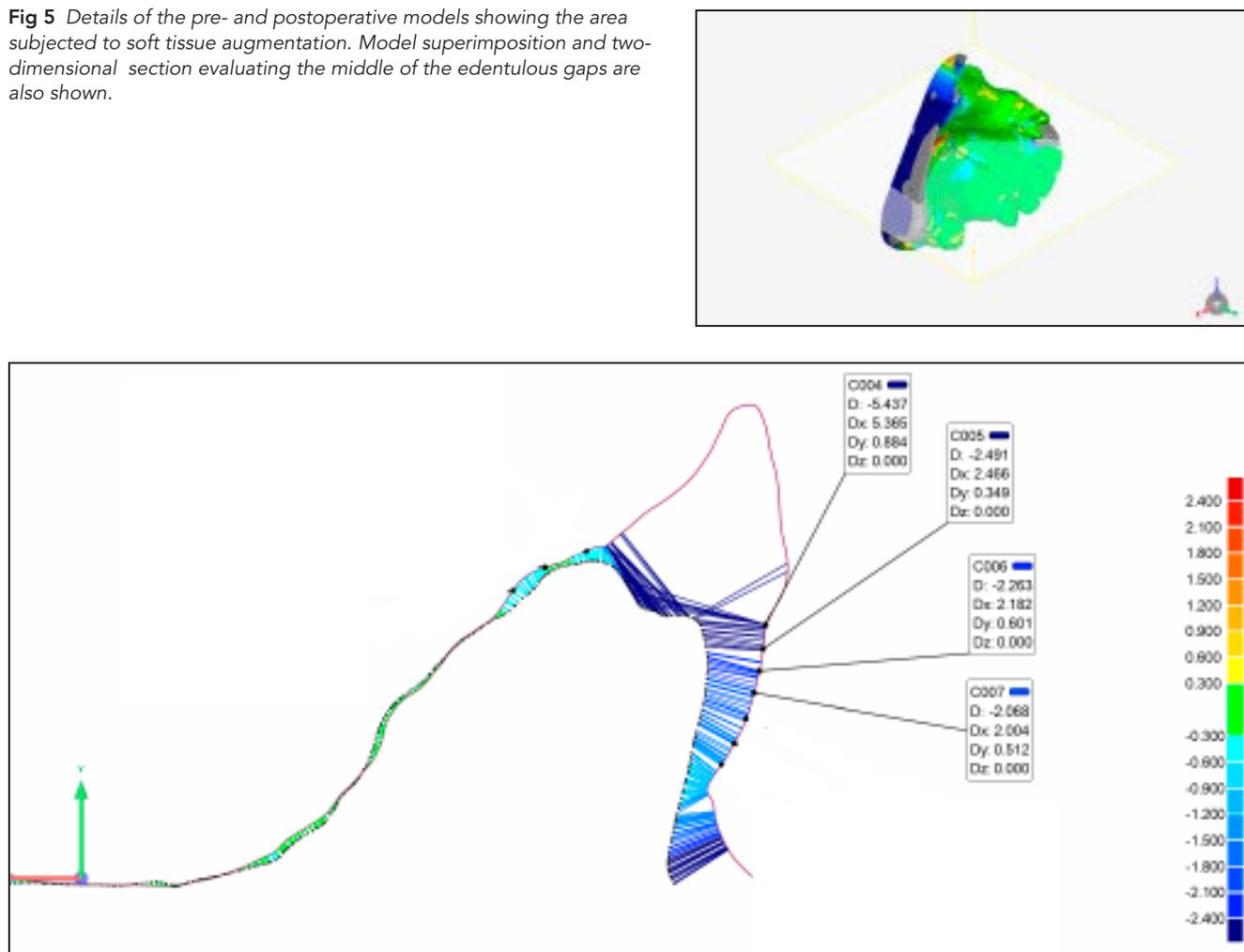
The radiographic data were analyzed using three-dimensional (3D) reconstruction software (Syngon MMWP, Siemens). The two CBCT scans were matched together, and the horizontal and vertical bone remodeling was measured. Buccal and palatal horizontal measurements were made at three levels:  $-2$  mm (coronal),  $-4$  mm (medium), and  $-7$  mm (apical) (Fig 4). Vertical loss was measured at a single point in the middle of the socket.

From baseline and 3-month impressions, cast models were made using dental stone (Esthetic-base gold, Dentona). The casts were scanned with a 3D laser scanner (D250, 3Shape). The STL files obtained from each model were subsequently transferred to a digital shape sampling and processing software for re-elaboration of 3D models from the 3D scan data (Studio, Geomagic). For each patient, presurgical and 3-month models were superimposed following a previously reported protocol.<sup>19</sup> Prior to taking the measurements, the presurgical model was set as the reference, while the postsurgical model was set as the test. For each superimposed model, two-dimensional labiopalatal sections were obtained in the middle of the extraction area, perpendicular to the alveolar crest. Subsequently, the linear distance between the preoperative and postoperative soft tissue profiles was measured. These measurements were taken beginning at the top of the crest and were repeated each millimeter for 4 mm in the apical direction (Fig 5).

#### Statistical analyses

Comparisons of data obtained at baseline and 3 months were performed using Student *t* test and signed rank test. Student *t* test was used for continuous variables, and Fisher exact test was used for categorical variables. For all analyses, the level of significance was set at  $P < .05$ . The calculations were performed using SAS version 9.3

**Fig 5** Details of the pre- and postoperative models showing the area subjected to soft tissue augmentation. Model superimposition and two-dimensional section evaluating the middle of the edentulous gaps are also shown.



for Windows (SAS) and the graphics software S-PLUS version 8.1 (TIBCO). Straightforward descriptive statistics were used to present the changes in the soft tissue profile from before to after surgery.

## Results

A total of 11 patients (6 women and 5 men; mean age: 46 years, range: 39–70 years) and 11 teeth were enrolled and treated in this study. No patients dropped out of the study over the 3-month follow-up period.

Of the 11 teeth extracted, 5 were premolars, 3 were lateral incisors, 2 were central incisors, and 1 was a canine. Of these, 9 teeth were extracted for endodontic reasons and 2 due to severe decay, which made restoration impossible. The healing period following the ridge preservation procedure was uneventful. After 10 days, the PEG membrane was no longer visible in all patients, and in 10 out of 11 patients the craters were covered with fibrin. Three months after surgery, complete closure and newly formed keratinized mucosa were observed in all sites.

### Horizontal and vertical alveolar bone dimension changes

Horizontal and vertical bone remodeling of the ridge from baseline to 3 months is shown in Table 1. Statistically significant bone loss was only observed buccally and palatally in the cervical region ( $-2$  mm) (buccal:  $-1.1 \pm 0.9$  mm,  $P = .0031$ ; palatal:  $-0.3 \pm 0.4$  mm,  $P = .018$ ). In addition, no significant differences were observed vertically ( $0.1 \pm 1.12$  mm;  $P = 0.81$ ). Soft tissue biotype (thick or thin) was not correlated with the level of bone resorption.

**Table 1** Changes in the horizontal and vertical bone ridge dimensions

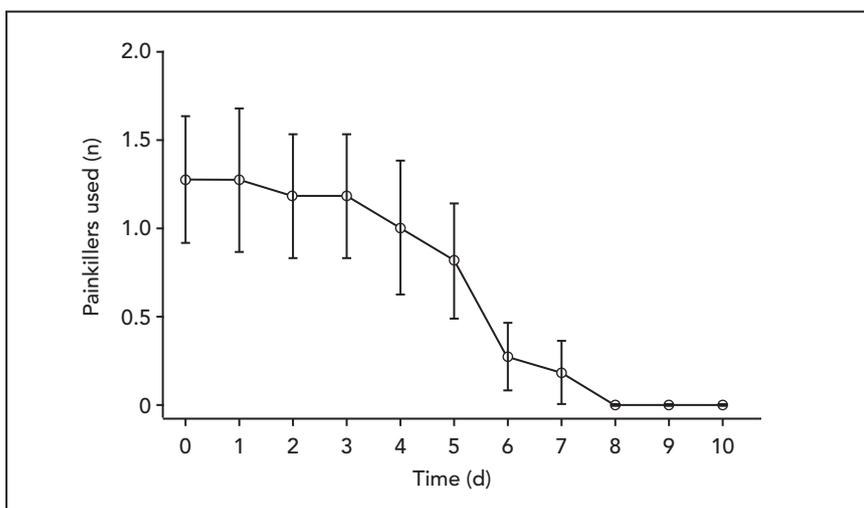
Variable	Buccal			Palatal		
	Mean	SD	P	Mean	SD	P
Coronal aspect (2 mm)	-1.06	0.91	.0031*	-0.31	0.36	.018 *
Medium aspect (4 mm)	-0.23	0.56	.21	-0.12	0.18	.052
Apical aspect (7 mm)	-0.23	0.61	.25	-0.10	0.11	.013
Vertical changes	0.09	1.21	.81			

\*Statistically significant.

**Table 2** Linear measurements (mm) showing the distance between the preoperative and postoperative vestibular profiles

Variable	Mean	SD	P
1 mm	-2.242	0.317	< .0001
2 mm	-1.826	0.635	< .0001
3 mm	-1.319	0.896	.0006
4 mm	-1.174	0.819	.0008

\*Statistically significant.

**Fig 6** Consumption of painkillers.

### Soft tissue contour changes

Buccal loss of soft tissue volume was observed in all patients, and mostly occurred in the 2 first coronal milli-

meters. In one patient, the gain was minimal at 3 and 4 mm. The linear measurements of the distance between the preoperative and postoperative vestibular profiles are shown

in Table 2. The variation in the buccal soft tissue profile at the extraction site from baseline to 3 months ranged from 0.94 to -2.88 mm.

### Morbidity

Analgesic consumption during the postoperative period significantly decreased after 4 days (Fig 6). The mean level of discomfort during and after the surgery was  $6.72 \pm 1.48$  and  $6.091 \pm 2.3$ , respectively.

### Discussion

Although various alveolar ridge preservation techniques have been reported to maintain the hard and soft tissue dimensions at extracted sites, no method has completely prevented physiologic bone resorption of the buccal plate.<sup>20</sup> The intention of the present study was to determine whether efficient preservation of the buccopalatal dimension of the alveolar ridge could be achieved by filling the socket with a nonresorbable biomaterial following osteotomy and buccal displacement of the bone plate. Using this expansion, the biomaterials would occupy the space of the former buccal wall. This technique emerged as an alternative to facial overlay socket preservation procedures, which showed a mean loss of  $0.3 \pm 0.8$  mm of tissue in the cervical region.<sup>16</sup>

However, significant alveolar bone dimension changes were observed, especially in the coronal area of the socket ( $-1.4 \pm 0.9$  mm). Therefore, this technique failed to

achieve less postextractional bone remodeling than several other extraction socket management methods described in the literature.<sup>21</sup>

With the present technique, the unexpected bone loss in the cervical area of the treated site may be attributed to an increase in inflammation associated with the osteotomy and the reduction of vascularization. Additionally, the repositioning of the buccal plate in a more apical direction may explain the high amount of bone loss in the coronal third of the alveolar ridge and the minor bone loss in the medium and apical thirds.

Consequently, in the absence of a connective tissue graft to compensate for buccal bone resorption,<sup>22</sup> the soft tissue contours in the buccal cervical third of the alveolar ridge are significantly diminished. A synthetic bioresorbable PEG hydrogel plug was used to contain the graft particles and guide the migration of keratinized soft tissue. Although some randomized controlled trials<sup>23</sup> and preclinical studies<sup>24</sup> have shown the effectiveness of using a PEG membrane in guided bone regeneration, in the present study when a PEG membrane was left exposed in the oral cavity, it was not detected in most of the patients at 10 days after the procedure and thus failed to guide the migration of keratinized soft tissue or act as a scaffold for soft tissue healing.

In this study, both postextractional bone remodeling and soft tissue contour changes were studied. However, these results must be interpreted cautiously, as the location of the bone measurements was apical compared with the location

of the soft tissue contour measurements. In future studies, it would be interesting to analyze soft tissue and bone-remodeling patterns using CT scans to study both parameters at the same level.

One of the conditions of the present study was the presence of an intact buccal plate. However, the extraction sites presented different soft tissue biotypes and various anatomical and dimensional characteristics of the hard tissue compartment. According to the literature, the relationship between the initial soft tissue biotype and postextraction bone remodeling is controversial. In recent studies in humans, some authors have reported that soft tissue biotype and socket wall thickness influence tissue remodeling processes after tooth extraction,<sup>25,26</sup> while others have concluded that alveolar ridge resorption occurs irrespective of soft tissue biotype.<sup>27</sup> In the present study, no correlation was found between the characteristics of the soft tissues at baseline and tissue modeling. However, the small sample size and the limited 3-month follow-up are drawbacks of the current investigation. Additional studies with large patient samples and a negative control group are necessary to identify specific trends and risk parameters that can serve as prognostic factors for this alveolar ridge preservation procedure.

## Conclusions

Within the limitations of the present study, buccal displacement of the buccal bone plate in conjunction

with the use of biomaterials did not prevent resorption of the alveolar contours. Moreover, its superiority over conventional extraction socket management approaches was not supported by the results of this study.

## Acknowledgments

The authors reported no conflicts of interest related to this study.

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