The Novel Periosteal Flap Stretch Technique: A Predictable Method to Achieve and maintain Primary Closure in Augmentative Procedures

Pooria Fallah Abed[1], Edgard El Chaar[2], Farhad Boltchi[3] and Seyed Hossein Bassir[4]

[1]Department of Periodontology, Texas A&M college of Dentistry, Dallas, TX, USA; [2]Department of Periodontology, School of Dentistry, New York, NY. USA; [3]Private Practice, Arlington, TX, USA; [4]Department of Periodontology, School of Dental Medicine, Stony Brook University, Stony Brook, NY, USA

Abstract

Background: Correct soft tissue management and achieving tension-free primary closure are pre-requisites for the success of bone augmentation procedures. Several techniques have been developed to facilitate a passive soft tissue primary closure. However, the current techniques are highly invasive and require advanced surgical skills. Hence, the present case series report will describe a novel and simple flap management technique.

Methods: The Periosteal Flap Stretch technique was utilized in bone augmentation procedures for four patients who presented with horizontal and vertical alveolar ridge deficiencies in the anterior maxilla, anterior mandible, posterior mandible, and posterior maxilla. This technique is performed using a blunt surgical curette that engages the periosteum of the mucosa below the mucogingival line of the full-thickness flap and stretches the periosteum in a coronal and outward direction, which results in stretching of the flap without the need for vertical or periosteal releasing incisions.

Results: Healing was uneventful for four all cases. No membrane exposure, no soft tissue dehiscence, or any other complications were observed during the six-months healing period after the respective bone augmentation procedures of cases.

Conclusions: The Periosteal Flap Stretch technique is a novel and simple technique that facilities achieving passive and predictable primary soft tissue closure.

Keywords: Alveolar Ridge Augmentation; Bone Regeneration; Dental Implantation; Surgical Flaps; Wound Closure Techniques.

Introduction

The replacement of missing teeth using implant-supported restorations is a widely accepted treatment modality (Derks *et al.,* 2015). A key pre-requisite for the success of implant therapy is placement of dental implants in an ideal prosthetically driven position since it directly affects the esthetic and functional outcomes as well as long-term stability of the peri-implant tissue (Fürhauser *et al.,* 2015). However, in many cases, implant site development surgery is required to address horizontal or vertical alveolar ridge deficiencies in partially or fully edentulous patients (Jensen *et al.,* 2009; Chiapasco *et al.,* 2009). Hence, several treatment modalities can be used to manage these alveolar ridge deficiencies such as onlay bone grafting, inlay bone grafting, guided bone regeneration, and the combination of the above using various surgical techniques and a variety of biomaterials (Jensen *et al.,* 2009; Chiapasco *et al.,* 2009).

Proper management of the soft tissues and achieving and maintaining passive primary closure are considered a key element for the success of these procedures (Retzepi and Donos, 2010). It has been demonstrated

Correspondence to: Pooria Fallah Abed, DDS, 3302 Gaston Ave, Dallas, TX 75246, Department of Periodontics. Email: fallahabed@tamhsc.edu

that lack of soft tissue closure during healing has a major negative effect on the quantity and quality of the regenerated hard tissue (Machtei, 2001) Several studies have reported unfavorable regenerative outcomes as result of the inflammatory response caused by soft tissue dehiscence (Machtei, 2001; Nowzari and Slots 1995). Maintaining soft tissue closure during the healing period is vital to prevent contamination and infection of the graft and barrier membrane (Simion *et al.,* 1994). In addition, lack of soft tissue closure may result in soft tissue ingrowth, barrier membrane migration, and early membrane degradation (Oh *et al.,* 2003; Moses *et al.,* 2005). Nonetheless, the incidence of soft tissue dehiscence and premature exposure of barrier membranes or grafts has been reported to be up to 50% in advanced bone augmentation procedures, where titanium mesh or non-resorbable barrier membranes are used (Rakhmatia *et al.,* 2013). Hence, a variety of techniques have been proposed to facilitate achieving a tension-free soft tissue primary closure such as vertical releasing incisions, advancement flaps, and periosteal releasing incisions (Ronda and Stacchi, 2011; Rosenquist, 1997).

A major challenge for clinicians is that the majority of the techniques that are used to attain primary soft tissue closure are highly invasive, technique sensitive, and require advanced surgical skills as well as good knowledge of anatomical structures. Moreover, vertical or periosteal releasing incisions not only may compromise blood supply to the graft site, which is important for the healing process, but also may cause severe bleeding and post-surgical swelling for the patient, which affects post-operative morbidity and patient's satisfaction with these procedures.

Due to the need for a simpler and less invasive flap management technique, this case-series article describes a novel and simple flap advancement technique that facilities achieving and maintaining tension-free soft tissue primary closure. This technique, Periosteal Flap Stretch (PFS) technique, utilizes a blunt instrument to create periosteal stretch in the flap without any need for vertical or periosteal releasing incisions.

Technique:

The Periosteal Flap Stretch technique involves a full-thickness flap raised following sulcular and papillary preservation incisions that are extended one or two teeth mesial and distal to the regenerative site without any vertical releasing incisions on the buccal and lingually intra-sulcular stopping at the line angle of the teeth involved (Figure 1a and Figure 2a). After performing hard tissue augmentation using bone grafting materials and barrier membranes (Figure 1b and Figure 2b), a blunt surgical Lucas curette or Buser periosteal elevator is used to create the periosteal flap stretch on the buccal surface. This is accomplished by the blunt surgical curette engaging the periosteum in a coronal and outward direction. Using a blunt instrument prevents the perforation of the flap. A tissue plier is used to support the flap while stretching the periosteum using the blunt curette (Figure 1c and Figure 2c). The same procedure is also completed for the lingual flap when the surgery is performed in the mandible and to prevent the damage to vital and sensitive organs in the floor of oral cavity. It is crucial to check the passivity of buccal and lingual flaps after performing this procedure. This can be assessed by displacing the flaps coronally and observing their overlap while completely covering the augmented site.

The primary suturing is performed using three horizontal mattress sutures at the base of the flaps one at the center, one at the most mesial and one at the most distal. Then, double single sling suturing technique is used for flap adaption around the most mesial and distal teeth, and single interrupted or continuous interlocking sutures are performed to achieve soft tissue primary closure (Figure 1d and Figure 2d).

This report outlines the application of the Periosteal Flap Stretch technique in four cases. All patients were informed about the treatment plan, the surgical technique, and the possible complications, and informed consent was obtained from the patients.

Case 1

A 42-year-old Asian female presented with an edentulous region in the anterior maxilla (missing teeth # 8 and 9) to the Department of Periodontology & Implant Dentistry, College of Dentistry, New York University in April 2014. Horizontal and vertical alveolar ridge deficiencies were evident at the edentulous site (Figure 3a and 3b). The patient was a non-smoker and she reported no significant medical problems. In addition, she was not taking any medication and she had no known allergies to any medications, metal, or food. The treatment plan included guided bone regeneration in conjunction with bone replacement grafts in the anterior maxilla followed by implant placement in the position of teeth # 8 and 9 after a six-months healing period.

A bone augmentation procedure was performed under local anesthesia. A sulcular incision was performed around teeth # 6, 7, 10, and 11, and a mid-crestal incision was made at the edentulous site. Then, full-thickness buccal and palatal mucoperiosteal flaps were reflected (Figure 3c). After performing cortical perforations, cortical particulate freeze-dried bone allograft (Puros, Zimmer Dental, Carlsbad, CA) was used to augment the edentulous site horizontally and vertically (Figure 3d). A non-resorbable barrier membrane (Cytoplast TM Ti-250, Osteogenics Biomedical, Lubbock, TX) was utilized to cover the grafting material and it was stabilized with membrane fixation bone tacks (truFIX, Ace Surgical Supply, Brockton, MA) (Figure 3e).

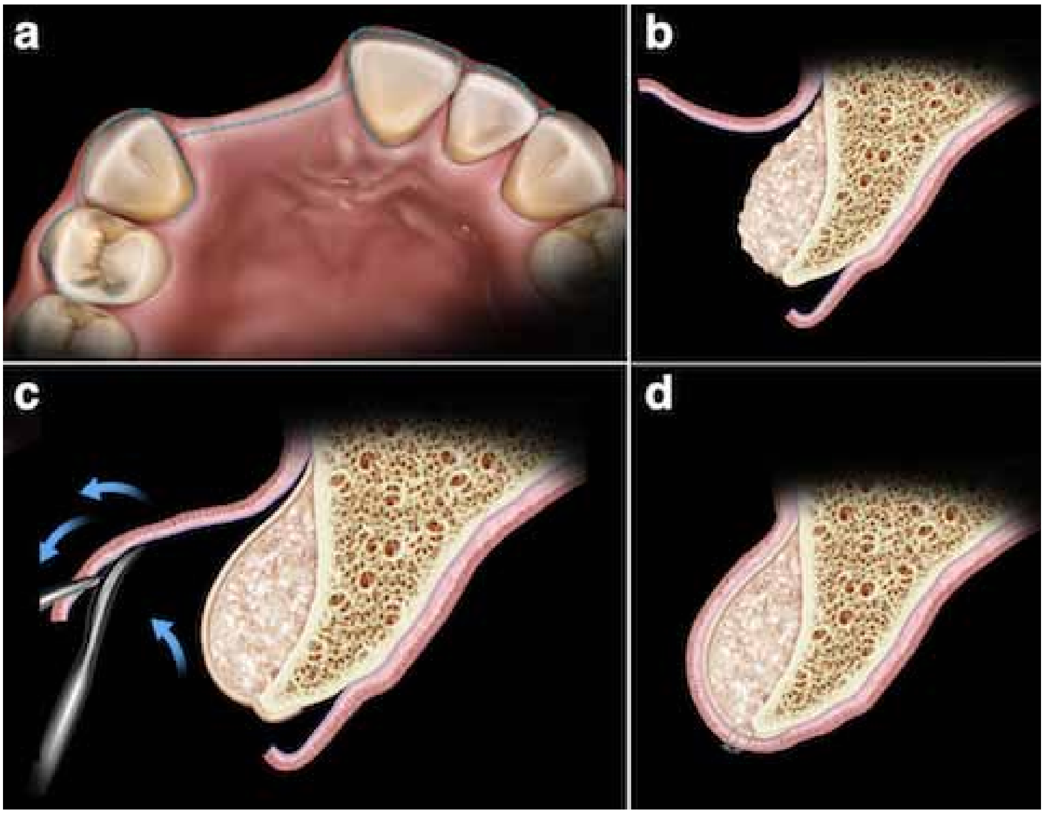

Figure 1. Schematic representation of the Periosteal Flap Stretch technique. a) Flap design: sulcular or papilla preservation incisions extended one or two teeth mesial and distal to the regenerative site are made without any vertical releasing incisions; b) bone augmentation can be done using bone replacement grafts with or without a barrier membrane; c) a blunt surgical curette engages the periosteum with motions in coronal and outward directions while the flap is supported with a tissue plier; d) tension-free soft tissue primary closure is achieved.

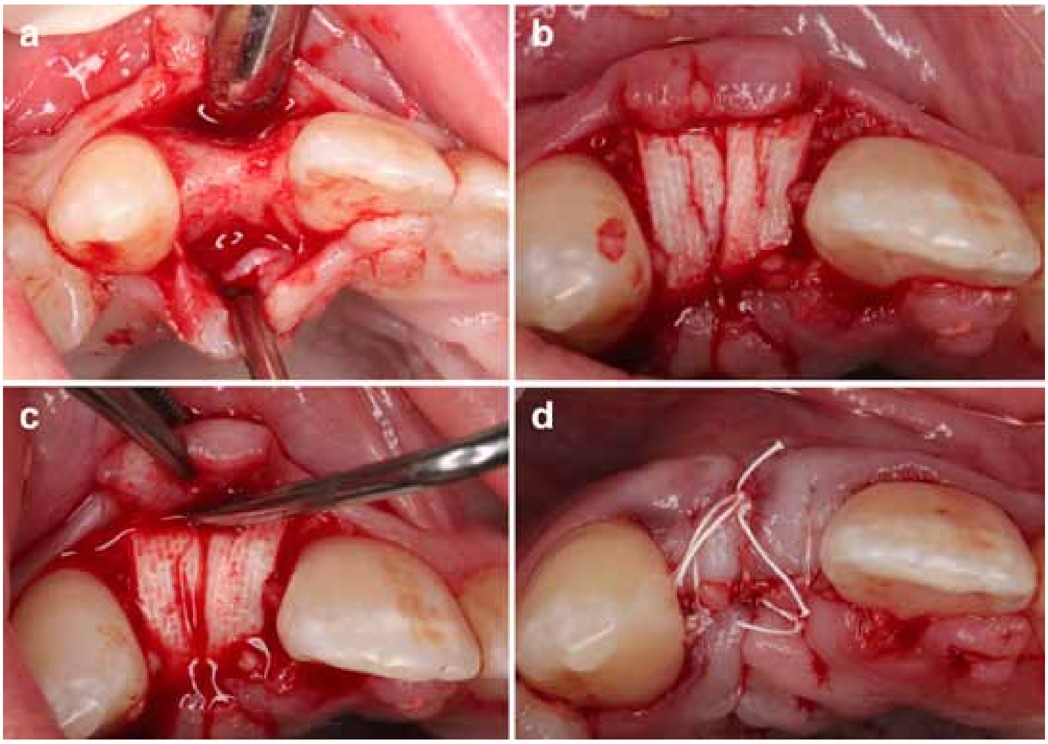

Figure 2. Clinical representation of the Periosteal Flap Stretch technique. a) Buccal and palatal full-thickness flaps were elevated at sites #7; b) bone augmentation was done using freeze-dried bone allograft and a resorbable collagen membrane. Note the position of the flaps after augmentation indicating the need for extensive advancement of the buccal flap; c) the buccal flap was supported using a tissue plier and a blunt surgical curette engaged the periosteum with motions in coronal and outward directions; d) tension-free primary closure was achieved using Periosteal Flap Stretch technique without any vertical or periosteal releasing incisions.

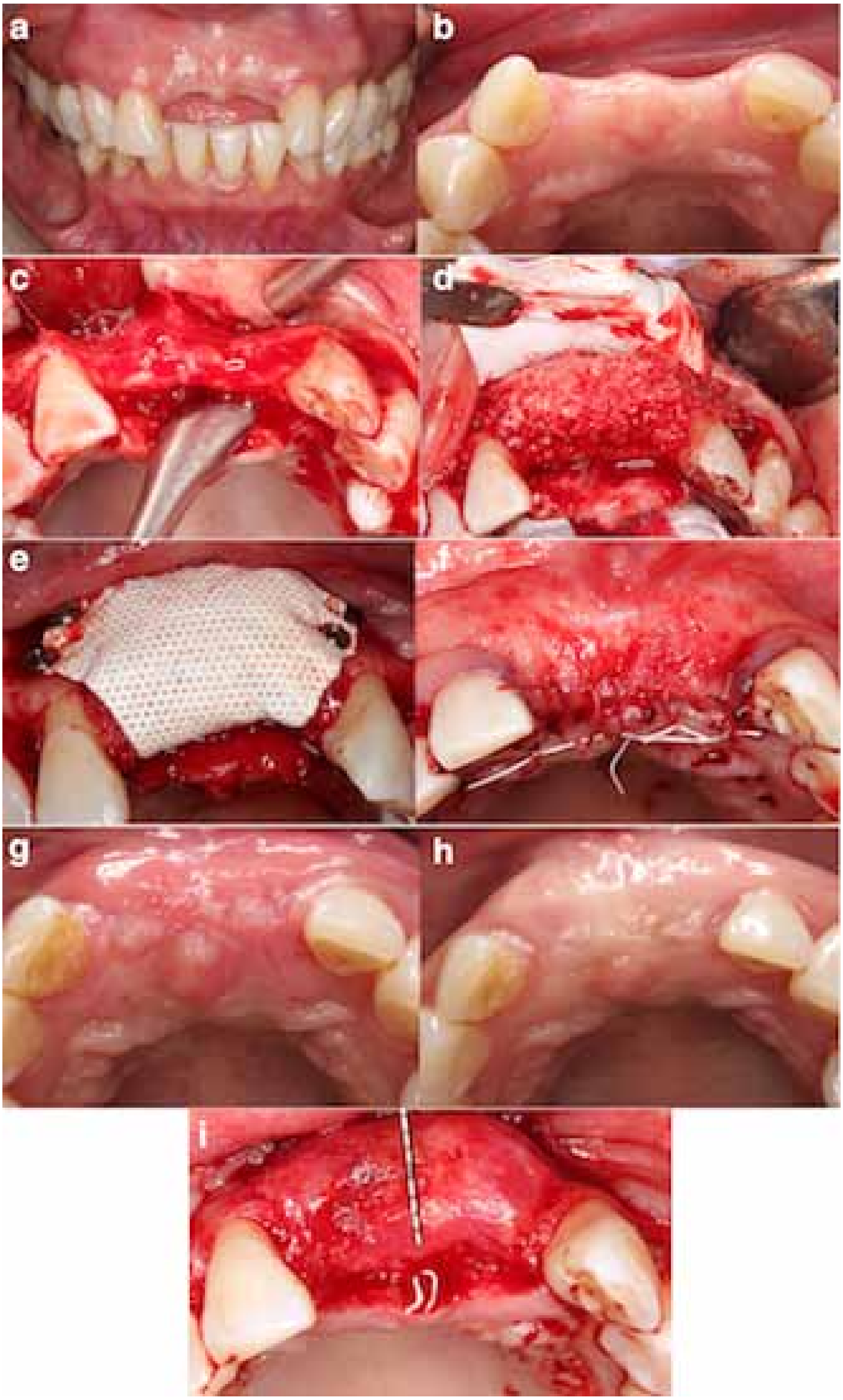

Figure 3- A clinical case of bone augmentation procedure using Periosteal Flap Stretch technique in the anterior maxilla. Buccal (a) and occlusal (b) photos demonstrate horizontal and vertical alveolar ridge deficiencies in the anterior maxilla; (c) a full thickness flap was elevated; (d) bone augmentation was performed using freeze-dried bone allograft; (e) bone graft was covered with a non-resorbable barrier membrane; (f) Periosteal Flap Stretch technique was used to facilitate passive primary closure; (g) healing after 4 weeks; (h) healing six months post-operatively; (i) re-entry surgery six months after the bone augmentation procedure.

The Periosteal Flap Stretch technique was used to facilitate a tension-free soft tissue primary closure. To do so, a blunt surgical curette was used to engage the periosteum with motions in coronal and outward directions while the buccal flap was supported with a tissue plier. After ensuring the passivity of the flaps, suturing was performed as outlined in the technique description using internal horizontal mattress sutures, double sling sutures, and single interrupted sutures. Subsequently, a tension-free primary closure was achieved (Figure 3f).

Post-surgical instructions were given to the patient. Amoxicillin (500mg TID for 7 days) chlorhexidine mouthwash (12 %, twice daily for two weeks), and appropriate anti-inflammatory analgesics were prescribed. Sutures were removed two weeks post-operatively. The patient was seen for the second post-operative examination four weeks post-surgically. Healing was uneventful, no complications were reported, and no membrane exposure was evident (Figure 3g).

Six months after the bone augmentation procedure, re-entry surgery was performed for the implant placement (Figure 3h). After elevation of a full-thickness flap, it was evident that width of alveolar ridge was grater than 8 mm, indicating the success of guided bone regeneration procedure (Figure 3i). Implant bed preparation was accomplished according to the protocol recommended by the manufacturer and the final prostheses were placed three months later.

Case 2

The second case involved a 65-year-old Middle Eastern female who presented to the Department of Periodontology & Implant Dentistry, College of Dentistry, New York University in January 2014. She had four missing mandibular incisors (teeth # 23- 26) and severe horizontal alveolar ridge deficiency at the edentulous area (Figure 4a). The only significant medical problem was grade 1 hypertension, which was well controlled with medications. She did not smoke cigarettes or any consume tobacco products, and she reported no known allergies to any medications, metal, or food. In this case, the proposed treatment plan involved bone augmentation in the anterior mandible using bone replacement grafts associated with a titanium mesh as well as implant placement after six months of healing in the position of teeth # 23 and 26.

After achieving local anesthesia, a sulcular incision was made around teeth #22 and 27 followed by papilla preservation incisions around teeth # 21 and 28 as well as a mid-crestal incision at sites # 23-26. A severe horizontal alveolar ridge deficiency was observed after the elevation of full-thickness buccal and lingual mucoperiosteal flaps (Figure 4b). Cortical perforations were performed. The edentulous site was augmented horizontally and vertically using freeze-dried bone allograft layered with cancellous particulate as first layer over the bone and the cortical particulate as the layer as the outer layer and the graft was stabilized using a titanium mesh (Figure 4c). As described in the previous case, the Periosteal Flap Stretch technique was used for both buccal and lingual flap advancement to facilitate primary closure. No periosteal releasing incisions were performed. The passivity of buccal and lingual flaps was then checked to ensure a passive soft tissue closure. Internal horizontal mattress sutures, double sling sutures, and single interrupted sutures were utilized for the soft tissue closure. A passive soft tissue primary closure was achieved (Figure 4d).

Post-surgical instructions and prescriptions were similar to those of the previous case. Suture removal was performed after two weeks (Figure 4e) and the patient was seen for a four-week follow-up session. In each follow-up session, the patient's home care was observed and oral hygiene instructions were reinforced. Uneventful healing without any complications was reported. No exposure of titanium mesh was evident during the healing period.

The re-entry surgery was performed six months after the bone augmentation procedure (Figure 4f). After achieving local anesthesia, a full-thickness flap was elevated, and the titanium mesh was removed. The amount of regenerated bone was sufficient to place two implants at sites #23 and 26, indicating the success of the bone augmentation procedure (Figure 4g). The final prostheses were delivered three months after implant placement.

Case 3

The third case involved a 52-year-old Caucasian female presented with the missing of teeth # 30-32 to the Department of Periodontology & Implant Dentistry, College of Dentistry, New York University in November 2013. Severe horizontal and vertical alveolar ridge deficiencies were observed at the right posterior mandible edentulous site (Figure 5a). The patient was generally healthy and non-smoker with no significant medical problems or any known allergy. The treatment plan comprised guided bone regeneration with the addition of bone replacement grafts in the right posterior mandible and implant placement in the position of site# 30 and 31 after a six-months healing period.

Local anesthesia was achieved, sulcular incisions were performed around teeth # 28 and 29, and a mid-crestal incision was made at site # 30-32. Full-thickness flaps were then elevated. Both vertical and horizontal alveolar ridge dimensional losses were observed (Figure 5b). Osteoperforations were done, and guided tissue regeneration procedure in combination with bone grafting was performed using freeze-dried bone allograft and a non-resorbable barrier membrane (Figure 5c).

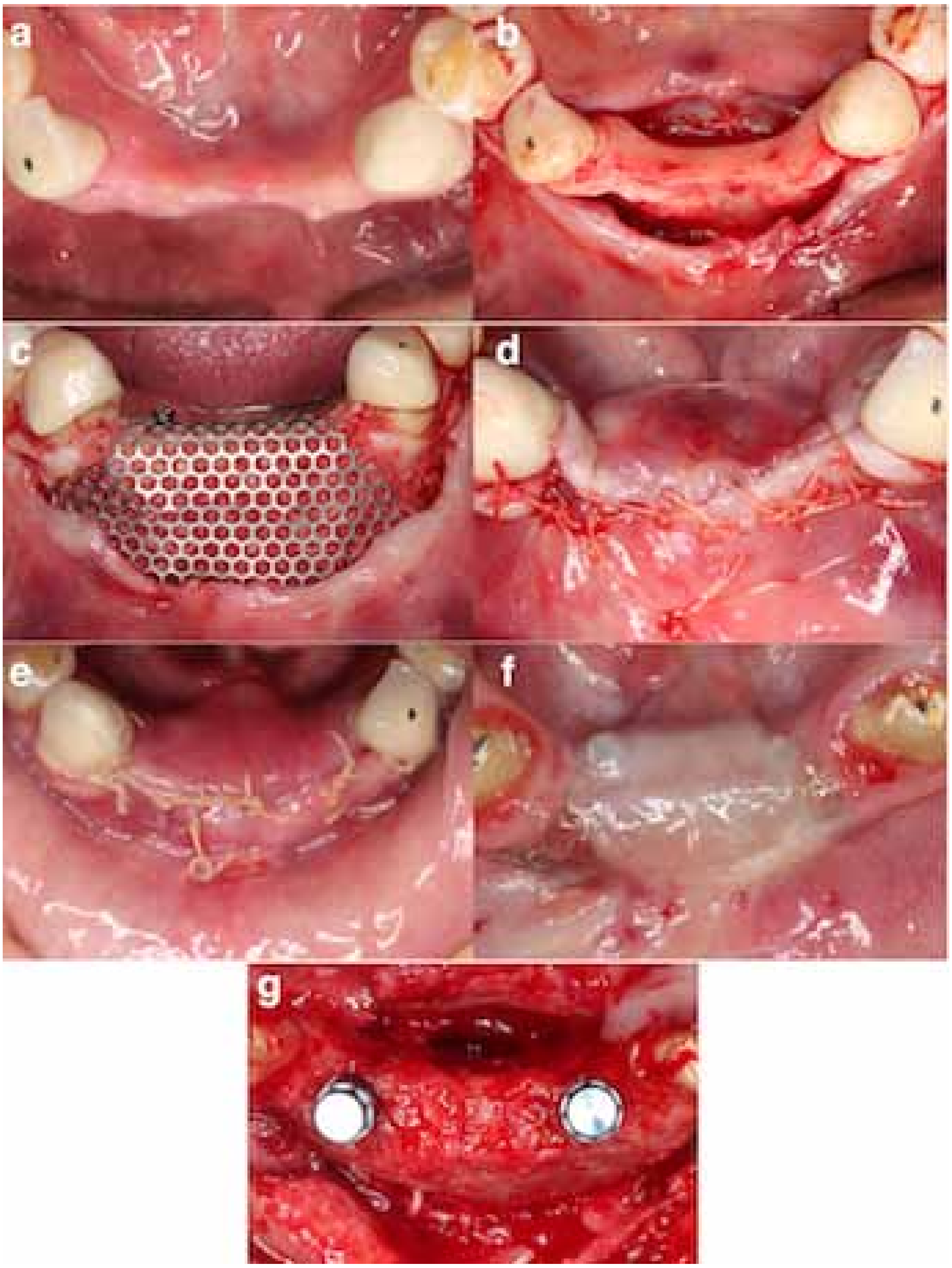

Figure 4. A clinical presentation of a bone augmentation procedure using the Periosteal Flap Stretch technique in the anterior mandible. (a) Pre-operative occlusal view demonstrating the horizontal alveolar ridge deficiency; (b) view after flap elevation; (c) bone augmentation was done using freeze-dried bone allograft stabilized using a titanium mesh; (d) tension-free primary closure was achieved using Periosteal Flap Stretch technique; (e) healing 2 weeks post-operatively; (f) healing six months after the augmentation procedure; (g) two implants were placed six months after the bone augmentation.

The Periosteal Flap Stretch technique was performed using a blunt surgical curette for buccal and lingual flaps without performing any periosteal releasing incisions. After assessing the passivity of the buccal and lingual flaps, suturing was performed using internal horizontal mattress sutures, double sling sutures, and continuous interlock sutures. A tension-free soft tissue primary closure was attained (Figure 5d).

Post-surgical instructions and prescriptions similar to those of previous cases were given. Sutures were removed after two weeks (Figure 5e). Patient was seen for the second follow-up session four weeks post-operatively. No membrane exposure was occurred, and uneventful healing without any complication was reported.

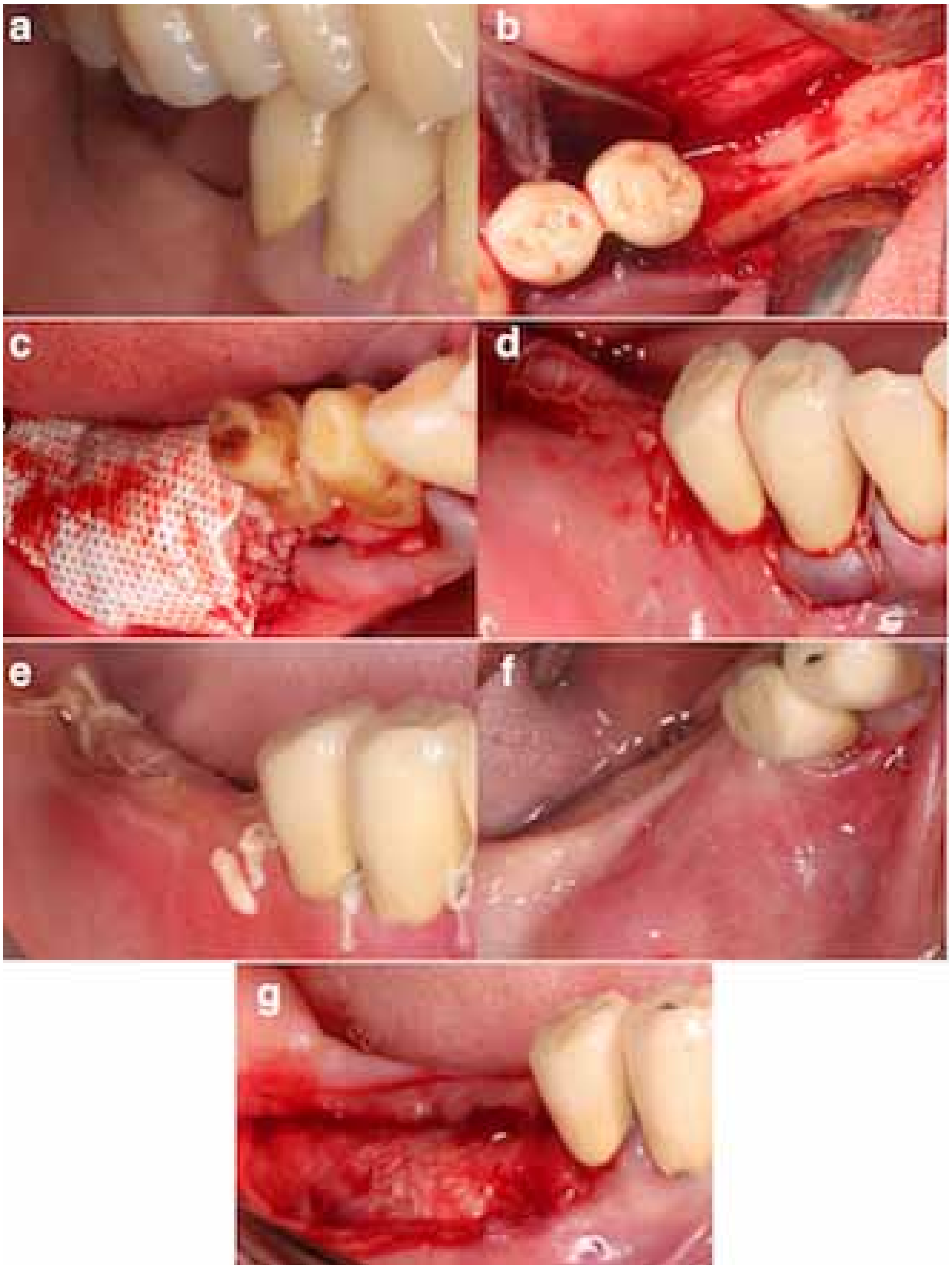

Figure 5. A clinical case of guided bone regeneration procedure using Periosteal Flap Stretch technique in the posterior mandible. (a) Pre-operative image; (b) horizontal and vertical ridge deficiency was evident after flap elevation; (c) guided bone regeneration was performed using a non-resorbable barrier membrane supported by freeze-dried bone allograft; (d) tension free primary closure was achieved after flap management using the Periosteal Flap Stretch technique; (e) healing two weeks after the surgery; (f) healing six months after the surgery; (g) re-entry surgery performed six months after the guided bone regeneration surgery.

Re-entry and implant placement surgery was performed after six months (Figure 5f). Adequate quantity of regenerate bone was evident (Figure 5g), and two implants were placed in the position of teeth # 30 and 31. Final implant-supported restorations were inserted after three months.

Case 4

A 60-year-old Caucasian male was seen for extraction of teeth # 12, 13, and 15 in March 2014 in a private practice office in New York City. Patient had lost the tooth # 14 several years ago. There were no significant medical problems or any known allergy, and he was not taking

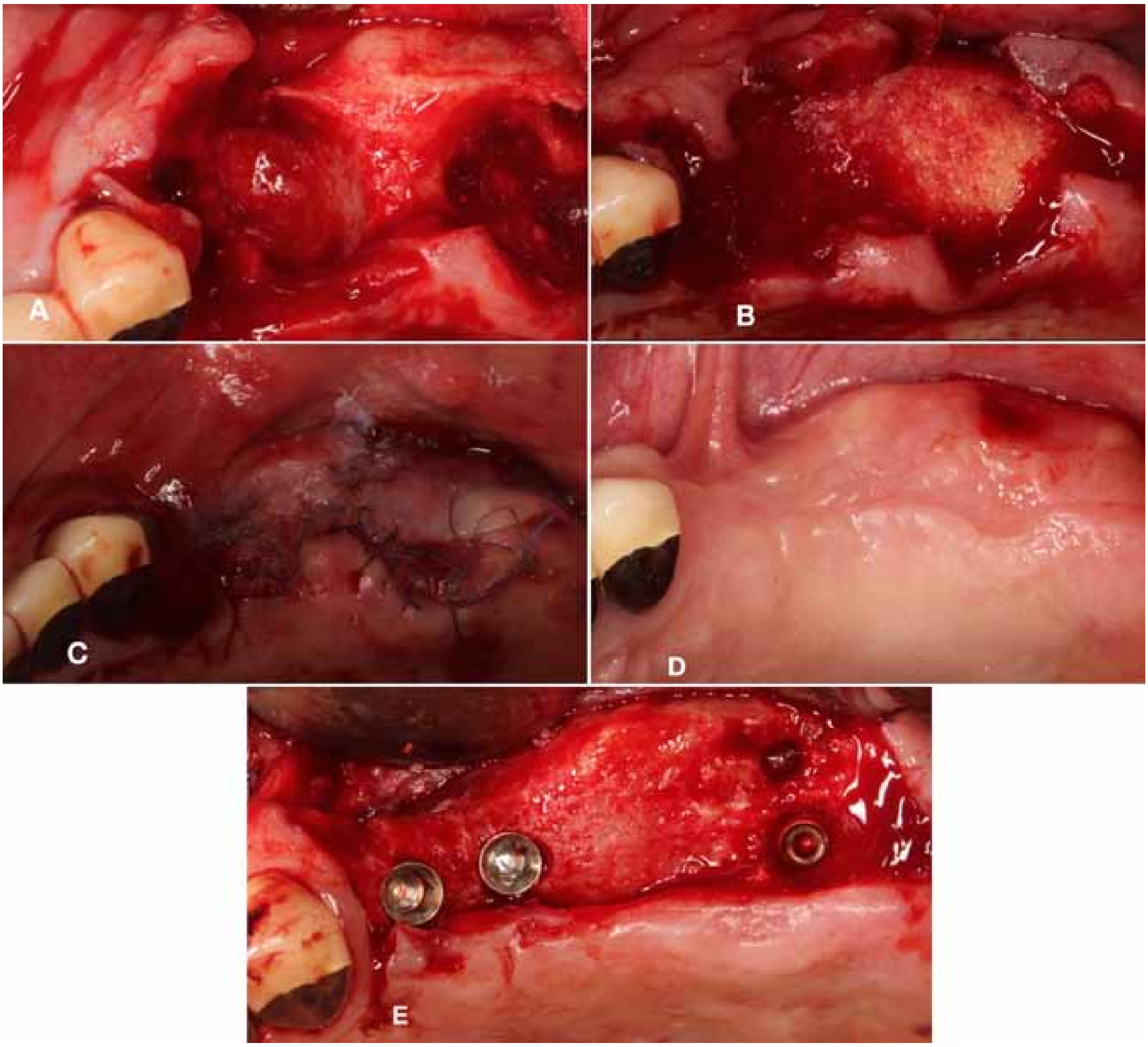

Figure 6. A clinical presentation of bone augmentation procedure using Periosteal Flap Stretch technique at the time of extraction in the posterior maxilla. (a) Immediately after extraction; (b) bone augmentation was done using demineralized bone matrix allograft material with bone chips; (c) passive primary closure was achieved after flap management using the Periosteal Flap Stretch technique; (d) healing six months post-operatively; (e) three implants were placed at the re-entry surgery done six months after the bone augmentation procedure.

any medication. The treatment plan included extraction of teeth # 12, 13, and 15, bone augmentation in the left posterior maxilla and implant placement in the sites # 12, 13, and 15.

Local anesthesia was achieved and teeth # 12, 13, and 15 were extracted. A full thickness flap was then elevated. After extractions, it was noted that teeth # 12 and 13 loss the buccal plates passing the apices (Figure 6a). Bone augmentation was done inside and outside the extraction sockets using demineralized bone matrix allograft material with bone chips (Puros demineralized bone matrix with bone chips, Zimmer Biomet, Carlsbad, CA) (Figure 6b). No barrier membrane was used in this case. The Periosteal Flap Stretch technique was performed for the buccal flap as described in the previous cases. The passivity of the buccal flap was assessed. Then, suturing was done, and a tension-free soft tissue primary closure was achieved (Figure 6c).

Post-surgical instructions were given. Sutures were removed two weeks post-operatively. Patient was seen for the second follow-up two weeks afterwards. No wound exposure was evident noted the healing period.

The re-entry procedure was done after six months (Figure 6d and 6e). A full-thickness flap was raised after achieving local anesthesia. The quantity of regenerated bone was sufficient to place three implants in the position of teeth # 12, 13, and 15 (Figure 6e). The final prostheses were inserted three months afterwards.

Discussion

A pre-requisite for the success of bone augmentation procedures is proper soft tissue management, which involves suitable incision design, flap management for tension-free wound closure, and an appropriate suturing technique (Buser *et al.,* 1996). Achieving a tension-free primary closure is one of main dilemmas facing clinicians performing bone augmentation procedures, and several techniques have been described to facilitate the achievement and maintenance of primary soft tissue closure (Ronda and Stacchi, 2011; Rosenquist, 1997)

In this paper, we describe the Periosteal Flap Stretch technique, which seems to be less technically demanding compared to other techniques that are used to facilitate primary closure such as vertical releasing incisions and periosteal releasing incisions. In addition, using a blunt instrument to create the periosteal stretch helps to maintain the flap's blood supply, reduces the chance of damaging vital anatomical structures, and makes this technique safer and less invasive compared to techniques with vertical or periosteal releasing incisions.

The Periosteal Flap Stretch technique may offer several biologic advantages and subsequent positive clinical consequences. In this technique, sharp dissections are avoided which helps to keep the vascular integrity of the flap. In addition, this technique decreases the need for vertical releasing incisions to achieve primary closures for augmented procedures. These may result in a better blood circulation at the edge of the wound (Zucchelli and De Sanctis, 2000), which is crucial for the wound healing and maintaining the primary wound closure. Furthermore, avoiding sharp dissections and vertical releasing incisions results in less bleeding compared to the conventional technique. This makes visibility of surgical field easier and reduces the overall surgical time, which may further result in less post-operative discomfort and complications (Tan *et al.,* 2014). Moreover, using the Periosteal Flap Stretch technique, the release occurs as a result of tension to periosteum and disruption in a dense connective tissue without damage to underlying vital structures such as nerve bundles and arteries which are more vulnerable to sharp dissections that have been used in traditional techniques.

The Periosteal Flap Stretch technique can be utilized with resorbable or non-resorbable barrier membranes or in cases where bone replacement grafts are used without any barrier membranes. In three of the presented cases, non-resorbable barrier membranes and titanium mesh were utilized to cover the grafting materials. Compared to resorbable barrier membranes, non-resorbable membranes or titanium meshes have rigid mechanical properties, which prevent barrier collapse and facilitate space-maintenance for bone augmentation (Ito *et al.,* 1998). However, their incidence of exposure or soft tissue dehiscence has been shown to be greater compared to resorbable barrier membranes (Rakhmatia *et al.,* 2013). Hence, the management of the flap to attain and maintain a passive soft tissue closure is more critical when using non-resorbable barrier membranes. It should be noted that in the case that titanium mesh was used the crest of the regenerated bone was sloped resulting in thinner peri implant crestal bone. It is not clear whether this outcome is related to the technique or use of titanium mesh. It should be mentioned that the main purpose of the present paper was to describe the technique by presenting four selective cases. Further controlled clinical studies are needed to verify the efficacy of this technique in a larger cohort of subjects.

Conclusions

Within the limitations of this case series report, it can be concluded that the Periosteal Flap Stretch technique is a novel and simple technique that facilities attaining and maintaining passive primary soft tissue closure without the need for vertical or periosteal releasing incisions. Future well-designed randomized controlled clinical trials are required to further assess the efficacy of this technique in a larger cohort of patients. Periosteal Flap Stretch (PFS) technique is a novel and simple flap advancement technique that facilities achieving and maintaining tension-free soft tissue primary closure without any need for vertical or periosteal releasing incisions with a blunt instrument. This technique provides a predictable tension-free primary closure with minimum trauma to the integrity of blood supply compared to other techniques.

Funding source

None

Disclosures

All authors have no conflict of interest.

References

Buser D, Dula K, Hirt HP and Schenk RK. Lateral ridge augmentation using autografts and barrier membranes: a clinical study with 40 partially edentulous patients. *Journal of Oral and Maxillofacial Surgery* 1996; **54:**420-432.

Chiapasco M, Casentini P and Zaniboni M. Bone augmentation procedures in implant dentistry. *International Journal of Oral & Maxillofacial Implants* 2009; **24:**237- 259.

Derks J, Håkansson J, Wennström J, Tomasi C, Larsson M and Berglundh T. Effectiveness of implant therapy analyzed in a Swedish population: early and late implant loss. *Journal of Dental Research* 2015; **94:**44S-51S.

Fürhauser R, Mailath-Pokorny G, Haas R, Busenlechner D, Watzek G and Pommer B. Esthetics of flapless single-tooth implants in the anterior maxilla using guided surgery: association of three-Dimensional accuracy and Pink Esthetic Score. *Clinical Implant Dentistry and Related Research* 2015; **17:**e427-433.

Ito K, Nanba K and Murai S. Effects of bioabsorbable and non-resorbable barrier membranes on bone augmentation in rabbit calvaria. *Journal of Periodontology* 1998; **69:**1229-1237.

Jensen SS and Terheyden H. Bone augmentation procedures in localized defects in the alveolar ridge: clinical results with different bone grafts and bone-substitute materials. *International Journal of Oral & Maxillofacial Implants* 2009; **24:**S218-236.

Machtei EE. The effect of membrane exposure on the outcome of regenerative procedures in humans: a meta-analysis. *Journal of Periodontology* 2001; **72:**512-516.

Moses O, Pitaru S, Artzi Z and Nemcovsky CE. Healing of dehiscence-type defects in implants placed together with different barrier membranes: a comparative clinical study. *Clinical Oral Implants Research* 2005; **16:**210-219.

Nowzari H and Slots J. Microbiologic and clinical study of polytetrafluoroethylene membranes for guided bone regeneration around implants. *International Journal of Oral & Maxillofacial Implants* 1995; **10:**67-73.

Oh TJ, Meraw SJ, Lee EJ, Giannobile WV and Wang HL. Comparative analysis of collagen membranes for the treatment of implant dehiscence defects. *Clinical Oral Implants Research* 2003; **14:**80-90.

Rakhmatia YD, Ayukawa Y, Furuhashi A and Koyano K. Current barrier membranes: titanium mesh and other membranes for guided bone regeneration in dental applications. *Journal of Prosthodontic Research* 2013; **57:**3-14.

Retzepi M and Donos N. Guided bone regeneration: biological principle and therapeutic applications. *Clinical Oral Implants Research* 2010; **21:**567-576.

Ronda M and Stacchi C. Management of a coronally advanced lingual flap in regenerative osseous surgery: a case series introducing a novel technique. *International Journal of Periodontics and Restorative Dentistry* 2011; **31:**505-513.

Rosenquist B. A comparison of various methods of soft tissue management following the immediate placement of implants into extraction sockets. *International Journal of Oral & Maxillofacial Implants* 1997; **12:**43-51.

Simion M, Baldoni M, Rossi P and Zaffe D. A comparative study of the effectiveness of e-PTFE membranes with and without early exposure during the healing period. *International Journal of Periodontics and Restorative Dentistry* 1994; **14:**166-180.

Tan WC, Krishnaswamy G, Ong MM, Lang NP. Patient-reported outcome measures after routine periodontal and implant surgical procedures. *Journal of clinical periodontology* 2014; **41:**618-624.

Zucchelli G, De Sanctis M. Treatment of multiple recession-type defects in patients with esthetic demands. *Journal of periodontology* 2000; **71:**1506-1514.