BALKAN JOURNAL OF DENTAL MEDICINE

BaSS

ISSN 2335-0245

Ridge Splitting Technique for Horizontal Augmentation and Immediate Implant Placement

SUMMARY

Insufficient width of the alveolar ridge often prevents ideal implant placement. Guided bone regeneration, bone grafting, alveolar ridge splitting and combinations of these techniques are used for the lateral augmentation of the alveolar ridge. Ridge splitting is a minimally invasive technique indicated for alveolar ridges with adequate height, which enables immediate implant placement and eliminates morbidity and overall treatment time. The classical approach of the technique involves splitting the alveolar ridge into 2 parts with use of ostetomes and chisels. Modifications of this technique include the use of rotating instrument, screw spreaders, horizontal spreaders and ultrasonic device.

The purpose of this article is to thoroughly describe all the different approaches in ridge splitting technique. 2 interesting clinical cases of narrow alveolar ridges treated with ridge splitting and immediate implant placement are also presented.

Keywords: Alveolar Ridge Augmentation; Dental Implants; Ridge Expansion; Ridge Splitting;Narrow Alveolar Ridge; Osteotomy

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CASE REPORT (CR)
Balk J Dent Med, 2014; 18:41-47

Introduction

Rehabilitation of partial or total edentulism with dental implants has been established as a predictable treatment modality with high success rates[1-7]. However, insufficient width of the alveolar ridge due to atrophy, periodontal disease or trauma may render implant placement impossible. In these cases, guided bone regeneration, bone grafting, alveolar ridge splitting and combinations of these techniques have been suggested for lateral augmentation of the alveolar ridge prior to implant insertion.

Guided bone regeneration (GBR) is a well documented procedure that has been successfully used for atrophic alveolar ridge augmentation[8-12]. However, relatively long healing time and the risk of membrane exposure that could result in bone loss or implant failure are the major limitations of this technique[13-17]. Autogenous bone grafts harvested from intraoral or extraoral sites are predictable alternative[18-20]. Nevertheless, bone grafting procedures are associated with inconveniences related to donor site morbidity, long healing time before implant placement and bone graft resorption[16,21-23].

Another treatment option for augmentation of the bucco-lingual dimension of the alveolar ridge is the ridge splitting technique, which was first described by Tatum[24]. The ridge splitting technique involves a longitudinal osteotomy on the residual ridge with the use of hand instrument[25], microsaw[26] or ultrasonic device[27]. A controlled greenstick fracture is created and the alveolar ridge is split in 2 parts. Osteotomes, chisels, horizontal spreaders or screw spreaders can be used for ridge expansion and lateral repositioning of the buccal bone plate in order to create a wider implant bed. The intrabony defect between the 2 bone plates is filled spontaneously with newly formed bone similarly to the healing procedure of an extraction socket[28]. However, filling the space with bone grafts alone or in combination with barrier membranes has been suggested in some clinical reports[29-33].

Compared with guided bone regeneration or bone grafting, the ridge splitting technique enables simultaneous implant placement, eliminates the need

for bone harvesting and reduces a risk of graft or membrane exposure. Therefore, the overall treatment time is shortened and morbidity is reduced[32,34-36]. On the other hand, this technique can be used for horizontal deficiencies, but not for vertical augmentation. Thus, it can be applied for augmentation of alveolar ridges with adequate height[25,36]. Furthermore, the ridge splitting technique requires a minimum of 3mm of bucco-lingual width with at least 1 mm of cancellous bone between the 2 cortical plates, which would allow introduction of instruments and the maintenance of good blood supply to the split parts[25,36-38].

The purpose of this paper is to present the ridge splitting procedure and the modified technique from those described in the literature. 2 interesting clinical cases with narrow alveolar ridges treated with the ridge splitting technique are also presented. In the first case ridge splitting was accomplished manually with the use of osteotomes and chisels. The second case was treated with a modified splitting technique using rotating instruments and horizontal bone spreaders (Meisinger Crest Control System).

Surgical Techniques

Classical approach of ridge splitting technique involves the use of osteotomes and chisels[25,30,32,39,40]. Under local anaesthesia, a full-thickness mucoperiosteal flap is elevated after mid-crestal and intra-crevicular incisions. A horizontal osteotomy that splits the alveolar ridge in 2 segments is achieved by gently tapping thin osteotomes or chisels with a mallet. In the mandible, 2 additional vertical osteotomies on the buccal bone plate are connected with the horizontal osteotomy because of the reduced flexibility of the mandibular cortical plates[31,32,35,41]. Then, a sequence of osteotomes of increasing size are used for the progressive expansion of the alveolar ridge until a 3 to 5 mm gap is established between the 2 segments. Twist drills are used for preparation of the implant beds and the implants are placed in the pre-planned positions. The space between the 2 bone plates can be filled with bone grafts or allografts alone or in combination with membranes.

Another ridge splitting technique includes the utilization of horizontal spreaders/expanders (Meisinger Crest Control Ridge Splitting System kit, Salvin Dental Specialties, Charlotte, NC). Initially, a round diamond bur is used to score the osteotomy site on the residual ridge. Then, a micro-saw is used for the initial osteotomy, which is deepened by a thin cylindro-conical bur to the desired depth. Horizontal spreaders are inserted in the osteotomy. Screw drivers open the horizontal spreaders to the final width. Finally, dental implants are placed immediately[42].

A modified splitting technique involves the use of rotating bone spreaders[38,43,44]. After the initial incision is made by the micro-saw, pilot burs create the appropriate depth for implant placement. A series of non-cutting bone spreaders of increasing diameters are used for the gradual densification of the cancellous bone and the expansion of the osteotomy. Dental implants can be placed simultaneously in the pre-planned positions.

Several clinical reports have referred the ultrasonic bone surgery technique[17,45,46]. This technique involves ultrasonic devices for creation of horizontal and vertical osteotomies in combination with the use of conventional osteotomes for the gentle lateralization of the buccal segment.

Case A

A 40-year old healthy woman presented for oral rehabilitation with fixed implant prostheses. Diagnostic casts, diagnostic wax-ups and a radiographic/surgical template were fabricated and a dental CT scan was performed. Clinical and radiographic evaluation revealed a narrow alveolar ridge in the maxilla, with sufficient height and cancellous bone between the two cortical bone plates (Fig. 1). Ridge splitting with osteotomes and chisels was planned in order to create the desired width for implant placement.

Fig. 1. Occlusal view of the narrow maxillary alveolar ridge

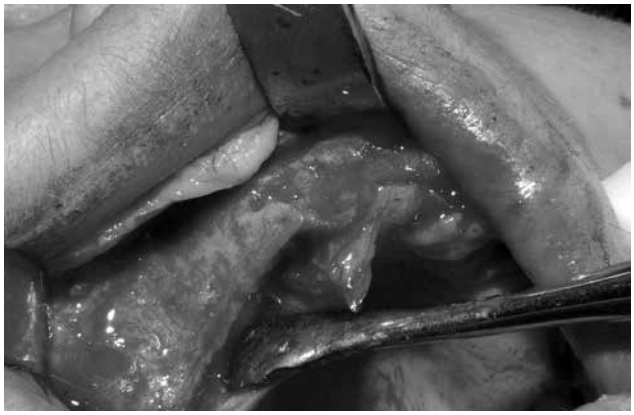

Fig. 2. Occlusal view after the elevation of a full-thickness mucoperiosteal flap

Fig. 3. A thin osteotome in use, creating the initial horizontal osteotomy

Fig. 4. Vertical osteotomies performed with the osteotome at the mesial and distal ends of the horizontal ostetomy

Fig. 5. Progressive widening of the gap between bone plates with the osteotome

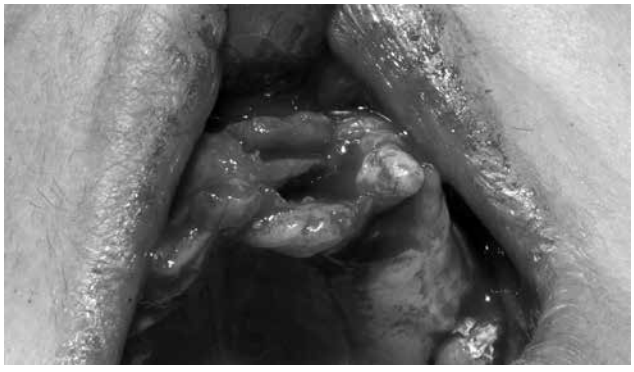

Fig. 6. View of the expanded maxillary alveolar ridge

Fig.7. Immediate implant placement

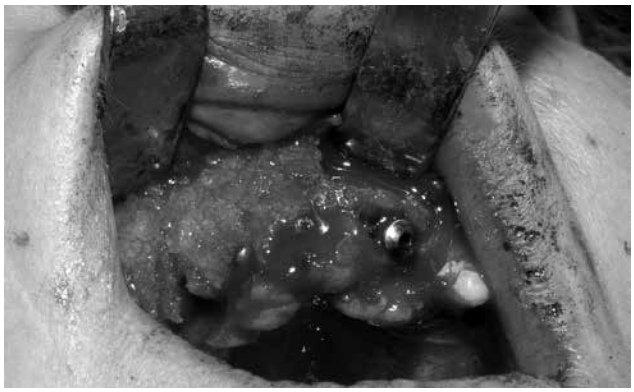

Fig. 8. Filling of the residual gaps with allogenic bone graft

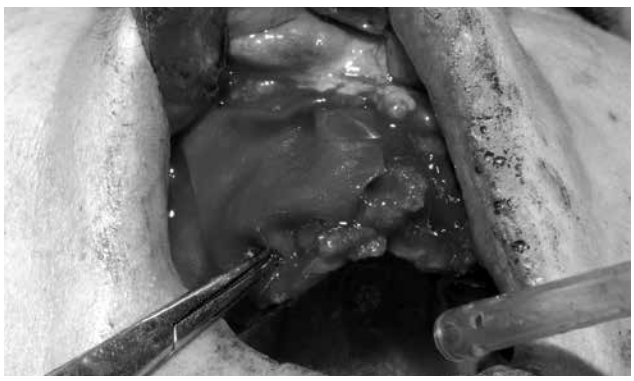

Fig. 9. Covering of the surgical site with a resorbable membrane

Under local anaesthesia, a mucoperiosteal flap was elevated after a mid-crestal incision (Fig. 2). The horizontal osteotomy was performed by gently tapping a thin osteotome with a mallet (Fig. 3). 2 additional vertical cuts were created on the buccal plate at the mesial and distal end of the horizontal incision (Fig. 4). Osteotomes of increasing size were used for the progressive lateralization of the buccal plate (Figs. 5 and 6). Dental implants were placed immediately in the preoperatively planned positions (Fig. 7). In order to promote healing and osseointegration, the residual space between the implants and the 2 plates was filled with allogenic bone graft

(Cells+ Tissuebank Austria) and covered with a resorbable membrane (Figs. 8 and 9). The patient received 500mg amoxicillin 3 times a day for 5 days and non-steroidal analgesics and she was advised to follow a soft diet and to use the provisional prosthesis only when necessary for aesthetics. A 12% chlorhexidine digluconate mouth rinse was also prescribed for 2 weeks. The implants were allowed to heal for 6 months prior to fabrication of the final prosthesis.

Case B

A 45-year-old man presented for implant treatment in the posterior maxilla. The evaluation of the dental CT scan revealed that the width of the alveolar ridge was inadequate for implant placement. A ridge splitting technique was planned. The Meisinger Crest Control Ridge Splitting System kit was used (Salvin Dental Specialties, Charlotte, NC), which consists of micro-saws, diamond burs and horizontal bone spreaders (Fig. 10). After elevation of a mucoperiosteal flap (Fig. 11), the initial horizontal osteotomy was performed with a micro-saw (Fig. 12). Then, a thin tapered diamond bur was used to deepen the initial osteotomy in the desired depth according to the implant length (Fig. 13). The horizontal spreader was inserted in the osteotomy and was opened with a screw driver in order to expand horizontally the alveolar ridge (Figs. 14 and 15). Twist drills were used for preparation of the implant beds (Fig. 16) and 2 implants were placed (Fig. 17). The residual gaps were filled with allograft material and covered by a resorbable membrane (Fig. 18).

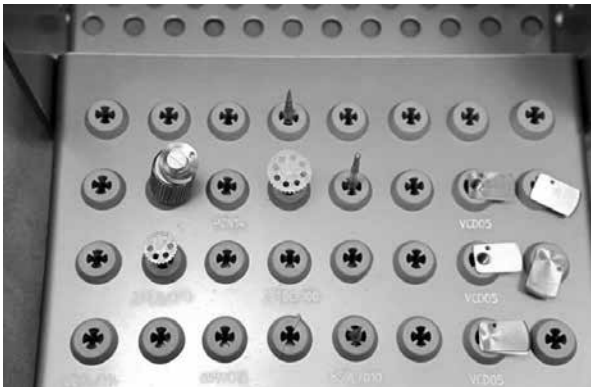

Fig. 10. View of the Meisinger Crest Control Ridge Splitting kit

Fig. 11. Elevation of a mucoperiosteal flap

Fig. 12. Initial horizontal osteotomy created with a microsaw

Fig. 13. Deepening of the initial osteotomy with a tapered diamond bur

Fig. 14. Insertion of the horizontal spreaders in the osteotomy

Fig. 15. View of the expanded ridge and the laterally repositioned buccal plate

Fig. 16. Preparation of implant beds

Fig. 17. Implant placement in the pre-planned positions

Fig. 18. Positioning of a resorbable membrane

Discussion

Horizontal atrophy of the alveolar ridge usually complicates adequate implant placement. GBR[8-12], bone grafting[18-20], alveolar ridge splitting[24-27] and combinations of these techniques have been suggested as treatment modalities to increase bucco-lingual dimension of the residual ridge. The ridge splitting technique is used for the horizontal augmentation of narrow alveolar ridges and allows simultaneous implant placement. Low morbidity and short treatment time are the major advantages of this technique compared to GBR and bone grafting procedures[32,34-36].

Several modifications of the ridge splitting technique have been described. In our clinics, ridge splitting is accomplished either with the use of osteotomes and chisels, or with the use of special equipment such as burs, micro-saws and horizontal spreaders. Compared to the osteotome technique, the use of spreaders provides better control of the amount of the expansion achieved, prevents excessive forces and patient discomfort produced by malleting[43,44,47]. On the other hand, the osteotome technique eliminates the need for special equipment.

Strong evidence for the effectiveness and the predictability of the ridge splitting technique is available in the literature. Clinical trials have reported success rates ranging from 98 to 100%. The survival rates of implants immediately placed in expanded sites ranged from 91% to 97.3%, while the success rates varied from 86.2% to 98.8% [25,28,31,42,48].

Complications during the surgical procedure are very rare - fracture of the buccal bone plate being reported as a major complication of the technique[49]. Controlled force application and gradual expansion could prevent malfractures[41,43]. In addition, a thorough preoperative evaluation is very important. The thickness of the cortical plates and the amount of the intervening cancellous bone must be carefully assessed preoperatively by dental CT scans. Last but not least, fabrication of radiographic/ surgical guide can prevent improper implant placement and angulation.

In conclusion, the ridge splitting technique seems to be a minimally invasive option for horizontal augmentation of narrow alveolar ridges. Predictable clinical results can be achieved as long as a proper preoperative evaluation is performed and a precise surgical protocol is followed.

Acknowledgements: This paper was completed as part of the postgraduate programme co-financed by the Act "Scholarships programme of the State Scholarships Foundation (IKY Scholarships) with an individualized assessment process of the Academic Year 2012-2013" from resources of the Operational Programme "Education and Lifelong Learning", of the European Social Fund (ESF), the NSRF 2007-2013. The authors declare no conflicts of interest with respect to the authorship and publication of this article.

References

1. *Albrektsson T, Zarb G, Worthington P, Eriksson AR*. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *Int J Oral Maxillofac Implants*, 1986; 1:11-25.

2. *Buser D, Mericske-Stern R, Bernard JP, Behneke A, Behneke N, Hirt HP, Belser UC, Lang NP*. Long-term evaluation of non-submerged ITI implants. Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants. *Clin Oral Implants Res*, 1997; 8:161-172.
3. *Lekholm U, Gunne J, Henry P, Higuchi K, Lindén U, Bergström C, van Steenberghe D*. Survival of the Brånemark implant in partially edentulous jaws: a 10-year prospective multicenter study. *Int J Oral Maxillofac Implants*, 1999; 14:639-645.
4. *Leonhardt A, Gröndahl K, Bergström C, Lekholm U*. Long-term follow-up of osseointegrated titanium implants using clinical, radiographic and microbiological parameters. *Clin Oral Implants Res*, 2002; 13:127-132.
5. *Lindquist LW, Carlsson GE, Jemt T*. A prospective 15-year follow-up study of mandibular fixed prostheses supported by osseointegrated implants. Clinical results and marginal bone loss. *Clin Oral Implants Res*, 1996; 7:329-336.
6. *van Steenberghe D*. A retrospective multicenter evaluation of the survival rate of osseointegrated fixtures supporting fixed partial prostheses in the treatment of partial edentulism. *J Prosthet Dent*, 1989; 61:217-223.
7. *Weber HP, Crohin CC, Fiorellini JP*. A 5-year prospective clinical and radiographic study of non-submerged dental implants. *Clin Oral Implants Res*, 2000; 11:144-153.
8. Buser D, Brägger U, Lang NP, Nyman S. Regeneration and enlargement of jaw bone using guided tissue regeneration. *Clin Oral Implants Res*, 1990; 1:22-32.
9. *Nevins M, Mellonig JT, Clem DS 3rd, Reiser GM, Buser DA*. Implants in regenerated bone: long-term survival. *Int J Periodontics Restorative Dent*, 1998; 18:34-45.
10. *Brunel G, Brocard D, Duffort JF, Jacquet E, Justumus P, Simonet T, Benqué E*. Bioabsorbable materials for guided bone regeneration prior to implant placement and 7-year follow-up: report of 14 cases. *J Periodontol*, 2001; 72:257-264.
11. *Hämmerle CH, Jung RE*. Bone augmentation by means of barrier membranes. *Periodontol 2000*, 2003; 33:36-53.
12. *Jung RE, Lecloux G, Rompen E, Ramel CF, Buser D, Hammerle CH*. A feasibility study evaluating an in situ formed synthetic biodegradable membrane for guided bone regeneration in dogs. *Clin Oral Implants Res*, 2009; 20:151-161.
13. *Machtei EE*. The effect of membrane exposure on the outcome of regenerative procedures in humans: a meta-analysis. *J Periodontol*, 2001; 72:512-516.
14. *Nyström E, Ahlqvist J, Kahnberg KE, Rosenquist JB*. Autogenous onlay bone grafts fixed with screw implants for the treatment of severely resorbed maxillae. Radiographic evaluation of preoperative bone dimensions, postoperative bone loss, and changes in soft-tissue profile. *Int J Oral Maxillofac Surg*, 1996; 25:351-359.
15. *Nevins M, Mellonig JT*. Enhancement of the damaged edentulous ridge to receive dental implants: a combination of allograft and the GORE-TEX membrane. *Int J Periodontics Restorative Dent*, 1992; 12:96-111.
16. *Chiapasco M, Abati S, Romeo E, Vogel G*. Clinical outcome of autogenous bone blocks or guided bone regeneration with e-PTFE membranes for the reconstruction of narrow edentulous ridges. *Clin Oral Implants Res*, 1999; 10:278-288.
17. *Blus C, Szmukler-Moncler S*. Split-crest and immediate implant placement with ultra-sonic bone surgery: a 3-year life-table analysis with 230 treated sites. *Clin Oral Implants Res*, 2006; 17:700-707.
18. *Lekholm U, Wannfors K, Isaksson S, Adielsson B*. Oral implants in combination with bone grafts. A 3-year retrospective multicenter study using the Brånemark implant system. *Int J Oral Maxillofac Surg*, 1999; 28:181-187.
19. *Chiapasco M, Romeo E, Vogel G*. Tridimensional reconstruction of knife-edge edentulous maxillae by sinus elevation, onlay grafts, and sagittal osteotomy of the anterior maxilla: preliminary surgical and prosthetic results. *Int J Oral Maxillofac Implants*, 1998; 13:394-399.
20. *Bahat O, Fontanessi RV*. Efficacy of implant placement after bone grafting for three-dimensional reconstruction of the posterior jaw. *Int J Periodontics Restorative Dent*, 2001; 21:220-231.
21. Felice P, Pistilli R, Lizio G, Pellegrino G, Nisii A, Marchetti C. Inlay versus onlay iliac bone grafting in atrophic posterior mandible: a prospective controlled clinical trial for the comparison of two techniques. *Clin Implant Dent Relat Res*, 2009; 11:e69-82.
22. *Schwartz-Arad D, Levin L, Sigal L*. Surgical success of intraoral autogenous block onlay bone grafting for alveolar ridge augmentation. *Implant Dent*, 2005; 14:131-138.
23. *Hodges NE, Perry M, Mohamed W, Hallmon WW, Rees T, Opperman LA*. Distraction osteogenesis versus autogenous onlay grafting. Part II: biology of regenerate and onlay bone. *Int J Oral Maxillofac Implants*, 2006; 21:237-244.
24. *Tatum H Jr*. Maxillary and sinus implant reconstructions. *Dent Clin North Am*, 1986; 30:207-229.
25. *Sethi A, Kaus T*. Maxillary ridge expansion with simultaneous implant placement: 5-year results of an ongoing clinical study. *Int J Oral Maxillofac Implants*, 2000; 15:491-499.
26. *Suh JJ, Shelemay A, Choi SH, Chai JK*. Alveolar ridge splitting: a new microsaw technique. *Int J Periodontics Restorative Dent*, 2005; 25:165-171.
27. *Blus C, Szmukler-Moncler S, Vozza I, Rispoli L, Polastri C*. Split-crest and immediate implant placement with ultrasonic bone surgery (piezosurgery): 3-year follow-up of 180 treated implant sites. *Quintessence Int*, 2010; 41:463-469.
28. *Bravi F, Bruschi GB, Ferrini F*. A 10-year multicenter retrospective clinical study of 1715 implants placed with the edentulous ridge expansion technique. *Int J Periodontics Restorative Dent*, 2007; 27:557-565.
29. *Koo S, Dibart S, Weber HP*. Ridge-splitting technique with simultaneous implant placement. *Compend Contin Educ Dent*, 2008; 29:106-110.
30. *Elian N, Jalbout Z, Ehrlich B, Classi A, Cho SC, Al-Kahtani F, Froum S, Tarnow DP*. A two-stage full-arch ridge expansion technique: review of the literature and clinical guidelines. *Implant Dent*, 2008; 17:16-23.
31. *Engelke WG, Diederichs CG, Jacobs HG, Deckwer I*. Alveolar reconstruction with splitting osteotomy and microfixation of implants. *Int J Oral Maxillofac Implants*, 1997; 12:310-318.
32. *Enislidis G, Wittwer G, Ewers R*. Preliminary report on a staged ridge splitting technique for implant placement in the mandible: a technical note. *Int J Oral Maxillofac Implants*, 2006; 21:445-449.

33. *Simion M, Baldoni M, Zaffe D*. Jawbone enlargement using immediate implant placement associated with a split-crest technique and guided tissue regeneration. *Int J Periodontics Restorative Dent*, 1992; 12:462-473.
34. *Han JY, Shin SI, Herr Y, Kwon YH, Chung JH*. The effects of bone grafting material and a collagen membrane in the ridge splitting technique: an experimental study in dogs. *Clin Oral Implants Res*, 2011; 22:1391-1398.
35. *Piccinini M*. Mandibular bone expansion technique in conjunction with root form implants: a case report. *J Oral Maxillofac Surg*, 2009; 67(9):1931-1936.
36. *Demarosi F, Leghissa GC, Sardella A, Lodi G, Carrassi A*. Localised maxillary ridge expansion with simultaneous implant placement: a case series. *Br J Oral Maxillofac Surg*, 2009; 47:535-540.
37. *Dene L, Condos S*. Ridge expansion and immediate implant placement in the esthetic zone. *N Y State Dent J*, 2010; 76:28-31.
38. *Chan HL, Fu JH, Koticha T, Benavides E, Wang HL*. Ridge width gain with screw spreaders: a cadaver study. *Implant Dent*, 2013; 22:552-558.
39. *Scipioni A, Calesini G, Micarelli C, Coppè S, Scipioni L*. Morphogenic bone splitting: description of an original technique and its application in esthetically significant areas. *Int J Prosthodont*, 2008; 21:389-397.
40. *Strietzel FP, Nowak M, Küchler I, Friedmann A*. Peri-implant alveolar bone loss with respect to bone quality after use of the osteotome technique: results of a retrospective study. *Clin Oral Implants Res*, 2002; 13:508-513.
41. *Sohn DS, Lee HJ, Heo JU, Moon JW, Park IS, Romanos GE*. Immediate and delayed lateral ridge expansion technique in the atrophic posterior mandibular ridge. *J Oral Maxillofac Surg*, 2010; 68:2283-2290.
42. *Chiapasco M, Ferrini F, Casentini P, Accardi S, Zaniboni M*. Dental implants placed in expanded narrow edentulous ridges with the Extension Crest device. A 1-3-year multicenter follow-up study. *Clin Oral Implants Res*, 2006; 17(3):265-272.
43. *Siddiqui AA, Sosovicka M*. Lateral bone condensing and expansion for placement of endosseous dental implants: a new technique. *J Oral Implantol*, 2006; 32(2):87-94.
44. *Nishioka RS, Souza FA*. Bone spreader technique: a preliminary 3-year study. *J Oral Implantol*, 2009; 35:289-294.
45. *Anitua E, Begoña L, Orive G*. Clinical evaluation of split-crest technique with ultrasonic bone surgery for narrow ridge expansion: status of soft and hard tissues and implant success. *Clin Implant Dent Relat Res*, 2013; 15:176-187.
46. *Anitua E, Begoña L, Orive G*. Controlled ridge expansion using a two-stage split-crest technique with ultrasonic bone surgery. *Implant Dent*, 2012; 21:163-170.
47. *Peñarrocha M, Pérez H, Garciá A, Guarinos J*. Benign paroxysmal positional vertigo as a complication of osteotome expansion of the maxillary alveolar ridge. *J Oral Maxillofac Surg*, 2001; 59:106-107.
48. *Scipioni A, Bruschi GB, Calesini G*. The edentulous ridge expansion technique: a five-year study. *Int J Periodontics Restorative Dent*, 1994; 14:451-459.
49. *Chiapasco M, Zaniboni M, Boisco M*. Augmentation procedures for the rehabilitation of deficient edentulous ridges with oral implants. *Clin Oral Implants Res*, 2006; 17:136-159.

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