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A modified edentulous ridge expansion technique and immediate implant placement: a 3-year follow-up

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Abstract:	Background: Restoration of the edentulous alveolar ridge with implants often requires the ridge width to be augmented in order to allow its placement. Aim: The aim of this study was to evaluate the split-crest technique, with subepithelial connective tissue graft, used as biological barrier, in patients with narrow ridges, focusing on the status of soft and hard tissues and on implant success rate, at 36 months after implant loading. Materials and Methods: Thirteen patients (6 male and 7 females), in the age group 32-68 years (mean 49.4 years) with an atrophic maxillary jaw underwent modified edentulous ridge expansion technique for implant placement. A total of 33 Laser-Lok tapered internal implant (Biohorizons, Birmingham, AL), were placed in the maxilla. The following parameters were evaluated: 1) initial ridge width (time t0); 2) ridge width at the time of abutment connection (time t1); four months after implants placement, healing abutments were connected and the prosthetic rehabilitation was initiated and all patients were evaluated clinically and radiographically with periapical radiograph at intervals of 3-6 months for the first year and annually thereafter for 3 years. The ridge width was measured with a cone beam computed tomography. Results: The initial ridge width ranged from 3.5mm to 7 mm (mean: 4.67 mm), while at the end of the expansion procedure the width ranged from 6.3mm to 11.0 mm (mean: 8.2 mm). The width gain of the edentulous ridge ranged from 1.45 to 4.9 mm (mean: 3.5 mm). Two implants became exposed one month after surgery. One implant was lost before loading (3%). The diameter of failed implant was 5.8 mm and length was 10.5 mm. The remaining 32 implants were stable and free of complications at the end of the study. Thus, the implant survival rate was of 97%. Because no implant failed after loading, the cumulative survival rate of loaded implants was 100%. Conclusion: The minimally invasive regenerative technique presented here avoids the use of bone graft, secondary surgery for soft tissue augmentation and mechanical expansion devices. However, the follow-up period for outcome evaluation and

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Abstract

Background: Restoration of the edentulous alveolar ridge with implants often requires the ridge width to be augmented in order to allow its placement.

Aim: The aim of this study was to evaluate the split-crest technique, with subepithelial connective tissue graft used as biological barrier, in patients with narrow ridges, focusing on the status of soft and hard tissues and on implant success rate, at 36 months after implant loading.

Materials and Methods: Thirteen patients (6 male and 7 females), in the age group 32-68 years (mean 49.4 years) with an atrophic maxillary jaw underwent modified edentulous ridge expansion technique for implant placement. A total of 33 Laser-Lok tapered internal implant (Biohorizons, Birmingham, AL), were placed in the maxilla. The following parameters were evaluated: 1) initial ridge width (time t_0); 2) ridge width at the time of abutment connection (time t_1); four months after implants placement, healing abutments were connected and the prosthetic rehabilitation was initiated and all patients were evaluated clinically and radiographically with periapical radiograph at intervals of 3–6 months for the first year and annually thereafter for 3 years. The ridge width was measured with a cone beam computed tomography.

Results: The initial ridge width ranged from 3.5mm to 7 mm (mean: 4.67 mm), while at the end of the expansion procedure the width ranged from 6.3mm to 11.0 mm (mean: 8.2 mm). The width gain of the edentulous ridge ranged from 1.45 to 4.9 mm (mean: 3.5 mm). Two implants became exposed one month after surgery. One implant was lost before loading (3%). The diameter of failed implant was 5.8 mm and length was 10.5 mm.

The remaining 32 implants were stable and free of complications at the end of the study. Thus, the implant survival rate was of 97%. Because no implant failed after loading, the cumulative survival rate of loaded implants was 100%.

Conclusion: The minimally invasive regenerative technique presented here avoids the use of bone graft, secondary surgery for soft tissue augmentation and mechanical expansion devices. However, the follow-up period for outcome evaluation and exiguous patient's number in this series was limited.

Key Words: Immediate implant, bone ridge expansion, dental implants, hard tissues, implant success, soft tissues, split-crest

Implant success is dictated by adequate bone foundation at the anticipated tooth replacement position. A minimum of 2 mm is necessary to ensure stable bone housing around the implant.[1] Even in impressive alveolar ridges, the ideal implant position may leave inadequate bone support. In the horizontal dimension, to achieve an adequate osseointegration and a good treatment outcome,

the presence of at least 1 mm in width around the implant bone crest at the buccal and palatal plane is required.[2] In patients with long-standing edentulous arches, extreme bone resorption (both vertically and horizontally) or combined defects are frequently presented. This fact leads inevitably to the use of additional techniques for augmentation of the local bone volume, including: osteoinduction, by the use of appropriate growth factors; osteoconduction, where a grafting material serves as a scaffold for new bone formation1; distraction osteogenesis, by which a fracture is surgically induced and the two bone fragments are then slowly pulled apart; guided bone regeneration, which allows spaces maintained by barrier membranes to be filled with bone; revascularized bone grafts, where a vital bone segment is transferred; and techniques for crest expansion using bone expanders or osteotomes, or with the technique called "split-crest" performed with an ultrasound device or with conventional surgery.[3-5]

The "split-crest" technique consists of splitting the vestibular and buccal cortical, displacing the vestibular cortical bone both in maxillary or mandible and separating from the bone marrow, and creating a middle gap, which is usually occupied mostly by the inserted implants.[3,6]

The unoccupied space by the implants can be filled with biomaterials such us autologous bone grafts, particulate bone, or plasma derivatives as platelet-rich plasma.[7]

The purpose of this paper was to document the application of modified edentulous ridge expansion technique with immediate implant placement over a 3-year period with a larger number of treated sites.

Material and methods

Inclusion criteria

Inclusion criteria were: (1) implant therapy was the elective treatment to restore partial or total edentulism, (2) the width of the alveolar ridge was less than 5.75 mm with impossibility of being able to use an optimal diameter implant expected, (3) the presence of medullary between bone buccal and palatal plate, (4) the alveolar ridge presented undercuts that would lead to implant fenestration, (5) Inability to insert dental implants prosthetically driven.

Surgical procedure

Details regarding the study protocol were recently described.[8]

The operation was performed under local anaesthesia.

Step 1: Design flap

A para-crestal palatal incision was outlined and a partial-thickness flap was dissected and elevated from the palate and reflected to the buccal portion of the alveolar crest.

Periosteum preservation was intended to reduce bone resorption and prevent free-fracture of the splitted ridge.

Step 2: Sagittal osteotomy

A sagittal osteotomy was outlined in the bone by scoring it with a No. 64 Beaver blade (BD Beaver, Waltham, MA, USA). The blade was used as a chisel and was tapped with a surgical mallet (Walter Lorenz, Germany) around 3 mm deep into the crestal ridge. Vertical bone releasing osteotomy was also carried out mesially and distally 2 mm away from the adjacent teeth. This was intended to give to the splitted segment enough elasticity and prevent accidental bone fracture of the moved bony segment.

Step 3: Osteotomes technique

Once the bony incisions were outlined, a bone chisel (Hu-Friedy Mfg. Co., Inc. Chicago, USA) was progressively driven deeper in the crestal osteotomy and the implant site can be prepared to the final depth with the osteotomes technique (Bone condenser – Silhouette Osteotomes, Biolok International Inc, USA).

Step 4: Implant placement

A tapered Internal with a laser micro-grooved coronal design (Biohorizons, Birmingham, AL) were gently tapped into position. Implant diameter was selected so to be slightly wider than the osteotomy sites to increase primary stability.

Step 5: Xenograft

The furrow between the bone plates was grafted (Putty, Rohen, TO, Italy).

Step 6: Connective tissue graft

Before suturing an autogenous connective tissue graft as biological barrier for better hard and soft tissue regeneration was layered over the bony wound. The connective tissue graft about 1.5 mm thicknesses was harvested from the palate. The donor site was selected from the palate, 2 mm below the gingival crestal margin. The connective tissue was placed above the implants and inserted under the vestibular and palatal residual keratinized mucosa. A suture was placed from the vestibular to the palatal site, stabilizing the connective graft. We used connective tissue graft covering the bony wound, in order to achieve augmentation keratinized mucosa in this region.

Step 7: Suturing

Periosteal sutures, with 4/0 Trofilorc sutures (LorcaMarìn, S.A. Murcia – Spagna), intentionally positioned the flap buccally and palatally for secondary-intention healing.

Step 8: Postoperative care

All patients received 2 gr of amoxicillin + clavunate per day starting approximately 1 h before surgery and continuing for 6 days after surgery and non-steroid analgesic postoperatively as needed. Postoperative instructions included a soft diet for 2 weeks and a rinse with 0,2 chlorhexidine solution until mechanical brushing could be resumed.

Sutures were removed approximately 10 days postoperatively.

CT scan evaluation and follow-up

The following parameters were evaluated:

1) initial ridge width, preoperative (time t0);

2) ridge width at the time of abutment connection (time t1);

The ridge width was measured with a cone beam computed tomography (CBCT), Scanora 3Ds (Soredex, Tuusula, Finland). The measurements were performed at time t0, and t1.

Four months after implants placement, healing abutments were connected and the prosthetic rehabilitation was initiated and all patients were evaluated clinically and radiographically with periapical radiograph at intervals of 3–6 months for the first year and annually thereafter for 3 years.

Implant success rates

The survival criteria proposed by Buser et al. and Cochran et al. were applied.[9,10] They were: (1) absence of clinically detectable implant mobility, (2) absence of pain or any subjective sensation, (3) absence of recurrent peri-implant infection and (4) absence of continuous radiolucency around the implant.

Demographics

Between January 2009 and Nov 2009, 13 modified edentulous ridge expansion (MERE) procedures were performed in 13 patients to receive 33 implants, tapered Internal with a laser micro-grooved coronal design (Biohorizons, Birmingham, AL). Patient age ranged between 32 and 68 years, mean age was 49.4 years; 53.85% (7) were females and 46.15% (6) were males. All implants (33) were placed in the maxilla. The majority of the sites (94%) concerned the posterior region.

Results

Thirteen patients (6 male and 7 females), in the age group 32-68 years (mean 49.4 years) were treated with the above method. The control low dose CT scan revealed a width gain of the edentulous ridges (Table 1). Ridge expansion with MERE technique was uneventful in all 13 patients. The initial ridge width ranged from 3.5mm to 7 mm (mean: 4.67 mm), while at the end of the expansion procedure the width ranged from 6.3mm to 11.0 mm (mean: 8.2 mm). The width gain of the edentulous ridge ranged from 1.45 to 4.9 mm (mean: 3.5 mm). In all 13 patients, 33 implants (Laser-Lok tapered internal implant, Biohorizons, Birmingham, AL) were placed immediately in the osteotomized and expanded areas and primary stability was always achieved. Patients data, number and type of implants, expansion of treated areas are reported in Table I. Two implants became exposed one month after surgery. One implant was lost before loading (3%). The diameter of failed implant was 5.8 mm and length was 10.5 mm. The remaining 32 implants were stable and free of complications at the end of the study. Thus, the implant survival rate was of 97%.

All other implants passed the second stage surgery and have been loaded for 36 months. Because no implant failed after loading, the cumulative survival rate of loaded implants was 100%.

Discussion

The split-crest procedure in combination with immediate implant placement has been described more than 10 years ago.[11,12] This procedure discards the need for onlay grafts taken from the hip, the symphysis of the chin, the maxillary tuberosity or the external oblique ridge. It avoids the use of a secondary surgical site that exhibits postoperative morbidity associated with bone harvesting; the GBR technique is also avoided. An additional advantage of the procedure is that immediate implant placement shortens the treatment and reduces the costs.

In relation to the osteotomy design, in split crest procedure, Enislidis et al.[14] have described a staged ridge splitting technique that may alleviate the poor success rate of the split crest technique. It consists of separating the surgery in two steps: the first, to mark the corticotomy sites via the buccal flap without mobilizing the bone segment; the second, to complete the osteotomies apically leaving the periosteum attached to the buccal surface of the bone segment, and generating a green-stick fracture. This technique reduces overall treatment time in comparison with onlay grafting procedures and avoids the need for a donor site. The technique requires a longer treatment period in relation to the above single-step technique. The presence of a better vascularized bone makes the modified split-crest technique a predictable method for the maxilla. For these cases, the authors believe that the staged ridge splitting technique is unnecessary.

Classical ridge-split procedures were performed only to expand the bone crest. In our case, with MERE technique, the focus was on soft tissues, in fact, was performed a subepithelial connective tissue graft as biological barrier to covering the bony wound, in order to achieving augmentation keratinized mucosa in this region. In this study, we constantly used the osteotome technique and the connective tissue graft like a cover, in fact, as compared with standard sagittal osteotomy, where the expansion of the atrophied site is obtained with chisels, the expansion with osteotome technique may allow a more gradual widening of the ridge and avoid excessive vestibular inclination of the fixture, with less risk of fracture of the osteotomized segments. In fact, traditional bone splitting techniques[3] present problems associated with the fact that the axis of rotation is situated at the apical end of the osteotomy with consequent excessive vestibular inclination of the implant body. This situation determine aesthetic and biologic problems; in fact the emergence profile of the implant-prosthesis is displaced vestibularly an apically with significantly reduced thickness resulting in tissue instability that can lead to recession and possibility exposure of the implant body.

The MERE technique escape this problems. Furthermore, the technique avoid possible complication like collagen membrane infection; in fact in case of the gap between buccal and palatal plates is very large and/or deep, one or more layers of equine lyophilized and resorbable collagen are placed within the coronal portion of the newly created alveolus.[3] This membrane comes soaked of oral cavity bacteria that can damage the below bone.

Results from our study demonstrated that horizontal deficient edentulous ridge may be successfully corrected with sagittal osteotomy and expansion with chisels and osteotome technique. With this technique is possible to obtain a bone volume gain mean of 3.5 mm. Therefore, the MERE technique was highly predictable. The survival rate of the placed implants was 97%, comparable with results obtained with standard implant placement procedures.12 The implant failure that we observed in patient 3, may be due to its large diameter: 5.8 mm.

In the present study, only two implants became exposed one month after surgery, but the exposure did not seem to affect bone healing, which upon clinical observation did not appear statistically different from the non-exposed implants. The fact that osseointegration was obtained despite these variations stresses the predictability of this novel osteotomy technique.

Vercellotti[15] further advanced ridge expansion beyond the malleted approach with the introduction of piezoelectric bone surgery. The Piezosurgery device provides a more controlled, precise, and histologically kind bony incision than rotary carbide and diamond burs.[16] Blus and Szmukler-Moncler[17] used this technology with immediate implantation in 57 patients over a period of 3.5 years and found a survival rate of 96.5% after 2 months of loading.

Recently, a new technique for atraumatic ridge expansion has been developed that introduces the surgical use of a piezoelectric device.[18,19]

Conclusion

The minimally invasive regenerative technique presented here avoids the use of bone graft, secondary surgery for soft tissue augmentation and mechanical expansion devices.

Within the limits of this ongoing prospective study, the following conclusions can be drawn that the technique appeared to be relatively uncomplicated and, finally, success rates of implants placed in the expanded areas were within the limits of criteria proposed by Buser et al. and Cochran et al.[9,10] and were consistent with those of implants placed in native bone.

However, the follow-up period for outcome evaluation and exiguous patient's number in this series was limited.

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Pz	Age (year)	Sex	Implant site	Diameter	Length	IBW (mm)	FBW (mm)	BVG (mm)	Compl.
1	39	M	13,14	3.8	12	5.24	7.51	2.27	No
2	47	F	23,24,25	3.8	12	4.9	9.4	4.5	No
3	38	F	14,15 16	3.8 5.8	12 10.5	5.8	8.87	3.07	No Failure
4	32	F	22	4.6	12	7	11	4	No
5	50	M	14,15 16	3.8 3.8	12 10.5	4.85	6.3	1.45	No
6	47	F	15,16	3.8	10.5	4.2	9.1	4.9	No
7	60	M	24,25 26	3.8	12 10.5	3.8	7.7	3.9	No
8	61	M	15 16,17	3.8	12 10.5	4.1	8.3	4.2	No
9	33	F	25 26	4.6	12 10.5	6.1	10	3.9	No
10	60	M	15,16	3.8	10.5	3.7	7.0	3.3	No
11	59	F	24,25 26	3.8	12 10.5	3.5	6.9	3.4	No
12	68	F	25 26,27	3.8	12 10.5	3.7	7.3	3.6	No
13	48	M	25,26,27	3.8	10.5	3.9	7.1	3.2	No

Table I. Anagraphic data of patients treated with MERE technique

Abbreviations: IBW, Implant Bone Width; FBW, Final Bone Width; BVG, Bone Volume Gain; Compl., complication

Table
Click here to download Table: Table 1.docx

Pz	Age (year)	Sex	Implant site	Diameter	Length	IBW (mm)	FBW (mm)	BVG (mm)	Compl.
1	39	M	13,14	3.8	12	5.24	7.51	2.27	No
2	47	F	23,24,25	3.8	12	4.9	9.4	4.5	No
3	38	F	14,15 16	3.8 5.8	12 10.5	5.8	8.87	3.07	No Failure
4	32	F	22	4.6	12	7	11	4	No
5	50	M	14,15 16	3.8 3.8	12 10.5	4.85	6.3	1.45	No
6	47	F	15,16	3.8	10.5	4.2	9.1	4.9	No
7	60	M	24,25 26	3.8	12 10.5	3.8	7.7	3.9	No
8	61	M	15 16,17	3.8	12 10.5	4.1	8.3	4.2	No
9	33	F	25 26	4.6	12 10.5	6.1	10	3.9	No
10	60	M	15,16	3.8	10.5	3.7	7.0	3.3	No
11	59	F	24,25 26	3.8	12 10.5	3.5	6.9	3.4	No
12	68	F	25 26,27	3.8	12 10.5	3.7	7.3	3.6	No
13	48	M	25,26,27	3.8	10.5	3.9	7.1	3.2	No

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