Preliminary Report on a Staged Ridge Splitting Technique for Implant Placement in the Mandible: A Technical Note

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Purpose: *Narrow edentulous alveolar ridges less than 5 mm wide require horizontal augmentation for the placement of screw-type dental implants. A staged approach to ridge splitting in the mandible to decrease the risk of malfracture during osteotomy is presented.* ***Materials and Methods:*** *Five consecutive patients with 6 long-span edentulous areas of the mandibular ridge were included in this study. After corticotomy of a rectangular buccal segment and a 40-day healing period, the mandibular ridge was split, leaving the buccal periosteum attached to the lateralized segment. Seventeen dental implants were placed, and the gap between the implants and the bone filled with a mixture of venous blood and a porous algae-derived hydroxyapatite.* ***Results:*** *All buccal segments fractured as planned at the basal corticotomy during ridge splitting. After 6 months, all implants were stable and surrounded by bone; prosthetic loading with fixed partial dentures was successful in all cases.* ***Discussion:*** *In the mandible, greenstick fracture during widening with osteotomes has not been controllable to date because of cortical thickness of the bone; the risk of malfracture during single-stage ridge splitting was high. With this approach, the location of the greenstick fracture is predetermined, and the perfusion for the buccal segment remains intact, although vascularization shifts from internal perfusion from spongy bone after the first intervention to external perfusion from the periosteum after the second intervention. The buccal cortical segment remains a pedicled graft after ridge splitting.* ***Conclusion:*** *The preliminary results of this report indicate that staged ridge splitting can be a safe technique which overcomes the problems associated with single-stage ridge expansion/ridge splitting procedures without causing significant delay in treatment.* Int J Oral Maxillofac Implants 2006;21:445–449

Key words: *augmentation, dental implants, mandible, osteotomy*

Narrow edentulous alveolar ridges less than 5 mm wide require bone augmentation before or after implant placement to establish a bony wall of at least 1 mm around screw-type implants.[1,2] Various surgical widening techniques have been described, including lateral augmentation with[3–5] or without guided bone regeneration (GBR),[4,6,7] ridge expansion osteotomy,[8–10] ridge-splitting technique with[11–14] or without[15] interpositional grafting, and horizontal distraction osteogenesis.[16]

The ridge-splitting technique aims at the creation of a new implant bed by longitudinal osteotomy of the alveolar bone. The buccal cortex is repositioned laterally by greenstick fracture, and the space between the buccal and lingual cortical plates is filled with autologous[11], allogenic,[13] or alloplastic[12, 13] graft material.

In the mandible, the risk of malfracture of the osteotomized segment is high because mandibular bone has less flexibility because of the thicker cortical plates. Thus, widening of the alveolar crest by ridge-split osteotomy should be combined with additional vertical cuts.[12] Basal greenstick fracture of the segments during widening with osteotomes has not been controllable to date. A staged approach to ridge splitting in the mandible to avoid complications is presented.

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MATERIALS AND METHODS

Five consecutive patients (2 men and 3 women; mean age, 42.1 years; range, 18 to 59 years) with 6 long-span edentulous areas of the mandibular ridge were included in this prospective study. Three inclusion criteria had to be met: inadequate buccolingual ridge dimension to allow the stable placement of dental implants (ie, ridge width less than 5 mm), at least 7 mm bone height above the mandibular canal, and at least 1 mm of cancellous bone separating buccal and lingual cortical plates in the edentulous area. Appropriate indication was based on panoramic radiographs and computerized tomography (CT). All patients were treated according to a staged protocol for horizontal augmentation.

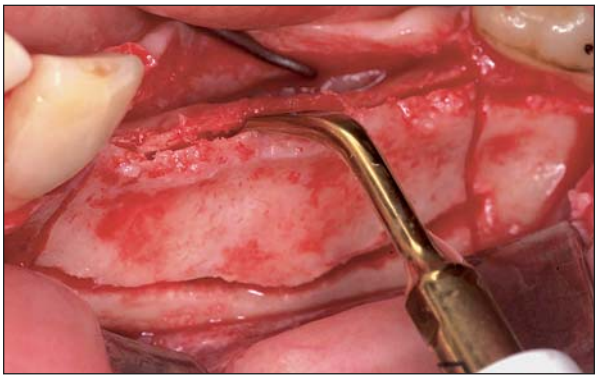


Fig 1 Rectangular buccal segment delineated with crestal, vertical, and basal horizontal corticotomies; the latter is located superior to the mandibular nerve canal. Note that the rectangular segment was not mobilized during the first surgical procedure.

Surgical Technique

Stage 1: Corticotomy. The first operation involved a simple corticotomy at the crestal, buccal aspect of the edentulous segment performed under local anesthesia.

After crestal and intracrevicular incisions had been made around the buccal aspect of the adjacent teeth, a mucoperiosteal flap was elevated to expose the buccal aspect of the mandible. Care was taken to keep the lingual periosteum attached to the bony surface. The piezosurgical device[14] (Mectron Piezosurgery; Mectron, Carasco, Italy) was set to boost C (the power level used for bone types 1 and 2)[17] and a crestal corticotomy line cut into the alveolar ridge (Fig 1). On the proximal and distal ends of the crestal corticotomy, vertical cuts were made on the buccal cortical plate; the length of the vertical corticotomies was determined on a case-by-case basis. The caudal ends of the vertical cuts were connected with a horizontal corticotomy. All osteotomies were 3 to 4 mm in depth, thereby only the cortical bone was dissected, and the cancellous bone was not significantly affected. The mucoperiosteal flap was repositioned and fixed with 4-0 or 5-0 nonresorbable sutures. Nonsteroidal analgesics, soft diet, and oral hygiene with 0.2% chlorhexidine mouth rinse was the standard perioperative protocol used for all patients. Sutures were removed after 10 days.

Stage 2: Ridge Splitting and Implant Placement. The second step included splitting and lateralization of the pedicled buccal bone segment 40 days after the primary operation. A crestal and intracrevicular incision around the lingual aspect of the adjacent teeth was performed to expose the area of the crestal osteotomy and to elevate a lingual full-thickness flap. A microscalpel (Beaver Mini-Blade, reference no. 376900; Becton Dickinson Surgical Systems, Franklin Lakes, NJ) was used as a chisel to separate the cortical plates from one another (Fig 2a). Care was taken to leave the buccal periosteum attached to the buccal cortical plate. Gradual lateralization of the buccal segment was then performed with a series of thin osteotomes after greenstick fracture at the base of the cortical segment until a 3- to 5-mm gap was established between the bone plates (Fig 2b).

Implant beds were prepared conventionally but without damage to the crestal bone, and dental implants (Xive; Friadent, Mannheim, Germany) were placed in the preplanned positions. The gap between the implants and the cortical plates was filled with a mixture of venous blood and porous algae-derived hydroxyapatite granules[18–20] (Algipore; Friadent, Mannheim, Germany) (Fig 3). The periosteum was incised in the lingual fold, and tension-free soft tissue closure was performed over the implants with 4-0 or 5-0 nonresorbable sutures. Patients received nonsteroidal analgesics, antibiotics (500 mg amoxicillin orally 3 times a day for 5 days), a soft diet, and 0.2% chlorhexidine mouth rinse after the operation. The sutures were removed after 10 days. Dentures or other restorations were not used for a period of 4 weeks following surgery to prevent irritation at the operated site.

Clinical monitoring was carried out immediately after stage-1 and stage-2 surgery and then 1, 3, and 6 months postsurgery, with visual examination of the healing tissues for any signs of inflammation. Radiographic examination was carried out using orthopantomograms immediately after each surgery (Fig 4) and before the uncovering of the implants after 6 months.

Stage 3: Prosthetic Loading of Implants. The submerged implants were allowed to heal for 6 months before uncovering and prosthetic loading.

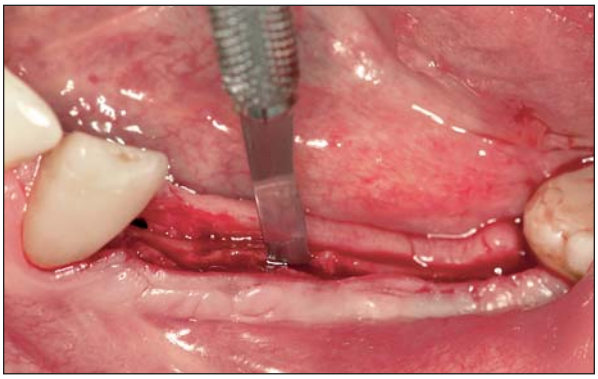


Fig 2a Ridge splitting with a microscalpel 40 days after corticotomy. The periosteum remained attached to the buccal surface of the mandible.

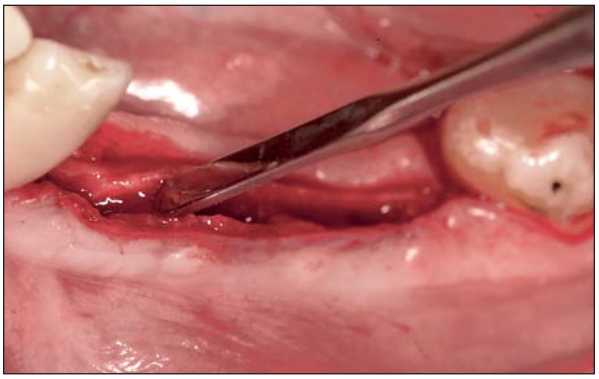


Fig 2b The gap between buccal and lingual cortical plates was widened with thin osteotomes after greenstick fracture at the basal horizontal corticotomy.

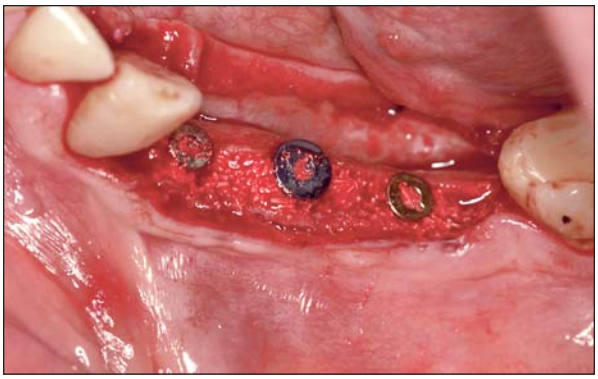


Fig 3 Three implants were placed, and the gap was filled with a mixture of venous blood and algae-derived porous hydroxyapatite. Note that a lingual flap was elevated.

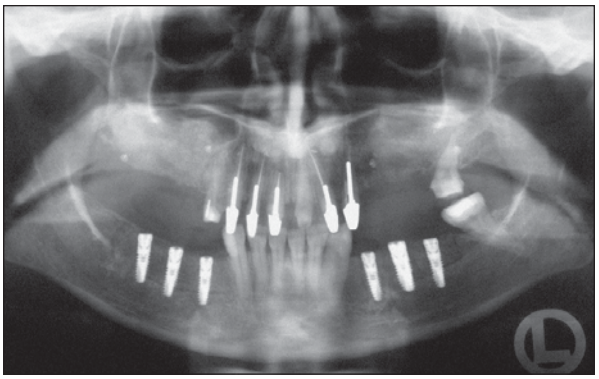


Fig 4 Panoramic radiograph immediately after implant placement. Corticotomy lines are still partially visible.

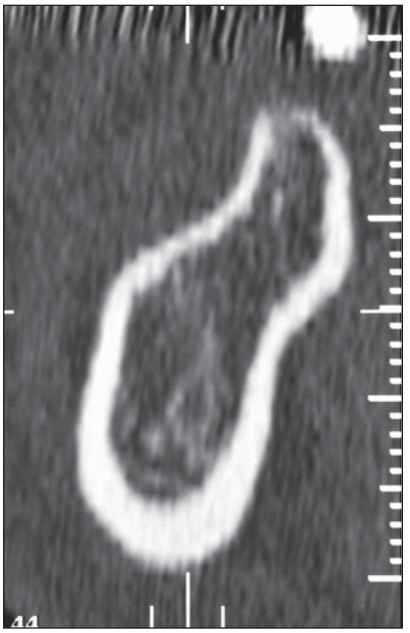
RESULTS

Access to the anterior and posterior mandible and surgical control of corticotomy depth was facilitated by the piezosurgery device. All buccal segments fractured at the basal corticotomy line during ridge splitting (Figs 5a and 5b), while the buccal periosteum remained attached to the bony surface. Soft tissue wound healing was uneventful. After 6 months, all implants were stable and surrounded by bone; prosthetic loading with fixed partial prostheses was successful in all cases for this short term (Table 1).

DISCUSSION

The width of narrow edentulous ridges can be increased by 3 different horizontal augmentation procedures: lateral augmentation, interpositional augmentation, and distraction osteogenesis.[16]

Lateral augmentation is a grafting procedure that requires a healing phase before implant placement. Attempts to shorten treatment time and place implants into narrow ridges simultaneously with lateral augmentation have not been successful to date.[3,5] Either particulate materials[4,5,21] or solid blocks[4,6,7] have been used for lateral augmentation. Particulate grafts usually need mechanical retention with GBR membranes[4] or similar devices.[21] To increase the width of narrow ridges, particulate grafts such as autogenous bone[4,21] or commercially available xenogenic[5] materials have been suggested. A major drawback associated with particulate grafts and GBR, apart from increased cost and morbidity when intraoral harvesting sites have to be accessed to gain autogenous bone transplants, is the risk of complicated healing and infection after membrane exposure.[3,4,15,21,22] In contrast, solid bone block onlay grafts[4,6,7] do not need retention or protection from ingrowth of soft tissues and therefore are usually not combined with membranes.[4] Hence, membrane exposure and infection are not issues with these procedures. However, long overall treatment time and increased morbidity arising from intraoral or extraoral donor sites are drawbacks.[23–25]



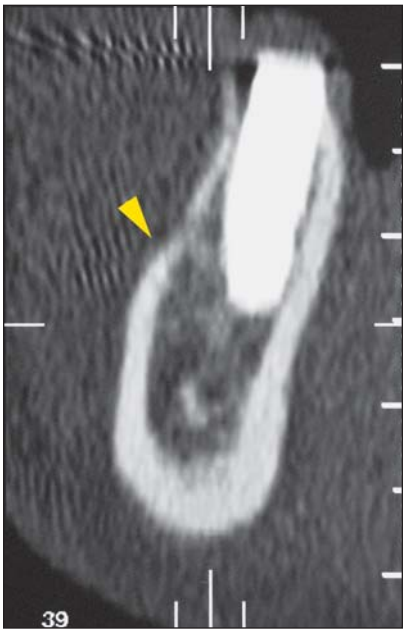


Fig 5a *(Left)* Initial dental CT scan with deformed narrow alveolar ridge.

Fig 5b *(Right)* Dental CT scan immediately after alveolar ridge split, lateralization of buccal segment, and implant placement (arrow indicates location of greenstick fracture).

Table 1 Summary of the Study Sample

Patient no.	Sex	Age	No. of implants	Implant		
				Location	Diameter (mm)	Length (mm)
1	F	56	2	29(45)	3.4	15
				30(46)	3.8	13
2	M	44	4	24(31)	3.0	15
				23(32)	3.0	15
				25(41)	3.0	15
				26(42)	3.0	15
3	F	59	3	28(44)	3.4	15
				29(45)	3.8	11
				30(46)	3.8	13
4	F	32	6	21(34)	3.4	13
				19(36)	4.5	13
				19(37)	3.8	13
				28(44)	3.4	13
				29(45)	3.8	13
				30(46)	3.8	13
5	M	18	2	19(36)	3.8	13
				18(37)	3.8	13

Universal (FDI) tooth numbers shown for implant location.

The degree of lateral onlay block graft resorption varies; resorption rates of 20% and 50% after 6 months have been reported.[7,26] In a different study, 91% of implants placed were successful at 24 months.

Interpositional augmentation is a demanding technique and subsumes 2 different approaches, ridge expansion[8–10] and ridge split procedures.[11–13,15,27] Interpositional augmentation is usually performed simultaneously with implant placement. The indication is limited to soft bone that permits osteocompression and/or greenstick fracture. Implants placed in maxillary bone in which the width was increased by means of interpositional augmentation have shown 5-year-cumulative success rates between 86% and 99%.[10,12,28] Attempts to use this procedure with stronger bone structures such as the mandible have not been successful[15] to date. The results of the present investigation indicate that the staged approach may be a solution to the problems inherent with the use of this technique in the mandible. Advantages of the technique include short overall treatment time, which makes this procedure superior to lateral aug-

mentation with bone block grafts, and elimination of the need to harvest autologous bone or use GBR membranes, which keeps morbidity and costs low. The unique features of this approach are that by dividing surgery into 2 steps, the location of the greenstick fracture is predetermined and predictable. In addition, the perfusion for the buccal segments remains intact, shifting from internal perfusion from spongy bone after the first intervention to external perfusion from the periosteum[29] after the second intervention, so that the buccal cortical segment remains a pedicled graft.

CONCLUSION

The preliminary results of this investigation indicate that the staged ridge-splitting technique can be an easy and safe procedure which overcomes the problems associated with single-stage ridge expansion/ridge-splitting procedures without causing significant delay in treatment.

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