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

Introduction
Rehabilitation of partial or total edentulism with dental implants has been established as a predictable treatment modality with high success rates. 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. 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. Autogenous bone grafts harvested from intraoral or extraoral sites are predictable alternative. Nevertheless, bone grafting procedures are associated with inconveniences related to donor site morbidity, long healing time before implant placement and bone graft resorption.

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. The ridge splitting technique involves a longitudinal osteotomy on the residual ridge with the use of hand instrument, microsaw or ultrasonic device. 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. Filling the space with bone grafts alone or in combination with barrier membranes has been suggested in some clinical reports.

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\textsuperscript{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\textsuperscript{25,30}. Furthermore, the ridge splitting technique requires a minimum of 3 mm 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\textsuperscript{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\textsuperscript{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\textsuperscript{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\textsuperscript{42}.

A modified splitting technique involves the use of rotating bone spreaders\textsuperscript{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\textsuperscript{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.

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

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

Complications during the surgical procedure are very rare - fracture of the buccal bone plate being reported as a major complication of the technique. Controlled force application and gradual expansion could prevent malfractures. 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.

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