

Modified Maxillary Ridge Splitting Technique for Horizontal Augmentation of Atrophic Ridge: Split Mouth Case Report

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Abstract

Insufficient bone thickness of an atrophic maxilla is a common problem for dental implants placement. Narrow edentulous alveolar ridge of 3 mm or less requires horizontal augmentation. Several surgical techniques have been mentioned in the literature: Guided bone regeneration, onlay block bone grafting, ridge split technique or ridge expansion and distraction osteogenesis This study demonstrates the outcome of the modified lateral ridge expansion technique, comparing one stage versus two stage technique in narrow, horizontally defected maxillary ridge.

Keywords: Ridge Splitting, Atrophic Maxilla, Piezosurgery, Sticky Bone, Bone Albumin Allograft.

Introduction

Deficient bone thickness is common for edentulous patients, especially when alveolar fracturing occurs during dental extraction. As the bone loss results from trauma, vertical root fracture, or from massive endodontic/ periodontal diseases, the deficiencies are even more severe. This might result in insufficient vertical and horizontal support to place dental implants and may impair, or even compromise, the options for prosthetic rehabilitation. In such cases, bone volume augmentation has to be considered an effective method for treatment [1].

Various techniques have been used successfully for the reconstruction of alveolar ridge bone volume include the use of onlay grafts harvested from extraoral source as the iliac crest, or intraoral sources as maxillary tuberosity, mandibular symphysis, or external oblique ridge. However, these procedures demand a second surgical donor site, which results in additional postoperative morbidity. Also, the recipient site often needs a healing period of [2-3] months before implant placement, and the risk of non-osseous integration of autogenous bone blocks is high [4].

Guided bone regeneration (GBR) and osteogenic distraction are also considered to improve the bone volume and enable prosthetic rehabilitation. These two techniques also present potential disadvantages, such as tissue dehiscence, displacement or collapse of the membrane, inappropriate dis-traction vector, unpredictable bone resorption, and a delay prior to installation of the implants [5].

An edentulous ridge expansion or split-crest technique (SCT) for implant placement was originally described by Simion, *et al.* [6] and later by Scipioni, *et al* [7]. A few literatures report different modifications of the ridge-split procedure with or without interposition bone grafting in the edentulous maxilla [2-8] and edentulous mandible [9-10]. The surgical procedure splits the cortical bone crests into

two half's, moving them away from each other to create a space in the centre, which is then mainly occupied by simultaneously inserted implants. The remaining areas can be filled with biomaterials, autogenous grafts, or autologous biological therapies such as plasma rich in growth factors or platelets rich fibrin [11]. The main advantages of the split crest technique (SCT) is the simple, quick, and predictable way in which the alveolar atrophic ridge can be expanded. This facilitates the use of bone grafts without the need for a second surgical site, thereby minimizing the risk of edema, nerve injury, and pain [2].

Several modifications of the SCT have been reported. Among these is the use of rotary and oscillatory instruments and, more recently, surgical ultrasound (US) such as piezosurgery. The latter allows precise, clean, and smooth cutting of the bone tissue, with excellent visibility. It is also believed that the use of piezosurgery could minimize the risk of complete fracture of the crests, which ultimately results in bone necrosis and implant failure [12]. Complete fracturing of the cortical crest is more likely along the edges where the remaining bone is highly mineralized. The SCT is recommended in cases where the vertical dimension of the alveolar ridge is acceptable, but its horizontal one is insufficient. Conversely, SCT should be contraindicated in those with atrophic ridges that lack elasticity due to a reduced volume of medullary bone tissue [13,14].

The SCT is based on an understanding of certain surgical principles. The following 3 characteristics should be evaluated when considering SCT [2]. The first one is bone density. The maxillary alveolar ridge is less dense than the mandibular alveolar ridge and more favourable to a single-stage SCT, whereas the mandibular alveolar ridge managed with a two-stage SCT. The second one is blood supply to the alveolar process and the role of periosteal vascularization. During an SCT, periosteum plays a critical role in vascularization of the buccal cortex and in graft osteogenesis. Gray, et al. [15] proved that at least one-third of early graft osteogenesis could be attributed to the periosteum alone. Meticulous tissue manipulation preserving the periosteum and its role in peripheral vascularization is extremely important in SCT [4].

The third characteristic relates to the treatment of the wound as a result of the SCT and appreciation of the wound healing by secondary intention. Primary closure is not applicable in most SCT cases. The widened alveolar ridge has to maintain its proper soft-tissue architecture (vestibule and keratinized tissue), and the labial soft tissue has to be undisturbed. After SCT, the alveolar ridges are treated openly and will heal by secondary intention analogous to the grafted extraction socket. A resorbable or non-resorbable membrane is used to retain graft material, isolate the wound from the oral environment, and guide the soft tissue's healing over the graft [2].

The purpose of this paper is to present the ridge splitting procedure and the modified technique from those described in the literature. An interesting clinical case with bilateral narrow alveolar ridges treated with the ridge splitting technique is presented. In one side, ridge splitting was accomplished manually with the use of osteotomes and chisels. The other side was treated with a modified splitting technique using rotating instruments and horizontal bone spreaders.

Case Description

A 27 years old male patient presented with bilateral edentulous areas at maxillary lateral incisors. He required implant supported fixed restoration to replace those missing teeth. A comprehensive oral examination was done to assess skeletal and dental maxilla-mandibular relationship, obtain proper radiographs, cone-beam computerized tomography (CBCT) is the ideal way to evaluate the 3D anatomy of the alveolar ridge and prepare diagnostic models (Figure 1a and 1b).

The CBCT showed narrow ridge (2.7mm for the left side and 3.04mm at the right side) (Figure 1c and d). A 3-mm alveolar ridge generally consists of 3 thin bone layers (in a horizontal sandwich fashion): 2 cortical plates (about 1 mm each) separated by 1 cancellous layer (about 1 mm). In the hands of a skilled surgeon, 2.5 mm and even 2 mm ridges can be splinted. The wider the cancellous bone layer (the layer where the split is done), the easier it will be to accomplish the SCT. Upon those data we decided to manage the case with SCT, expansion and implant placement. A full thickness conventional pedicle flap was elevated extended from the mesial side of maxillary left canine to the distal surface of maxillary right canine (Figure 2-a and b).

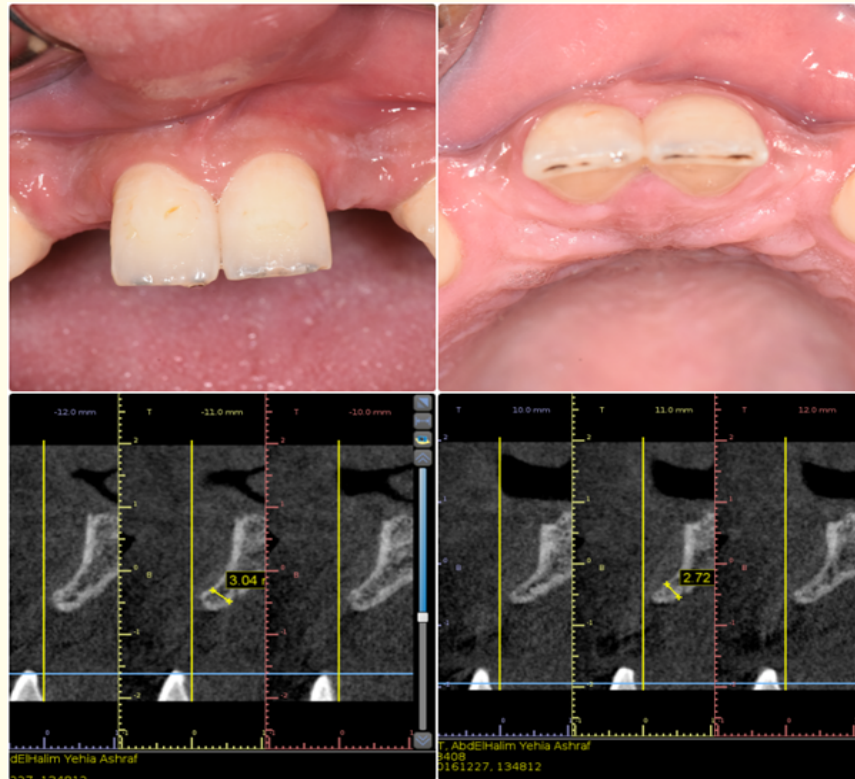


Figure 1

Concerning the right side, SCT was done using peizo-surgery (Figure 2-c) followed by expansion using Microdent expanders till reaching the required sufficient ridge thickness (Figure 2-d). Implant placement was carried out with caution, but upon insertion, labial bone fracture happened upon the adjacent canine (Figure 3-a). This situation was managed by augmenting the fractured bone and the sub-crestal deficient ridge opposite the placed implant using sticky bone “orthosera bone albumin allograft” was used and Medifuge silfra-dent system@ (Figure 3-b and c). And by that the right sticky was managed by one stage SCT.

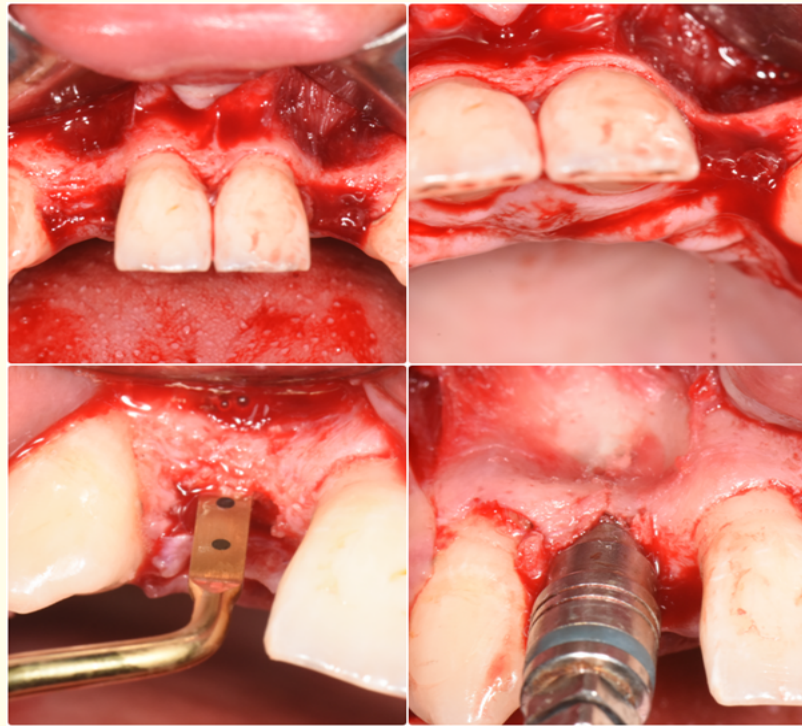


Figure 2

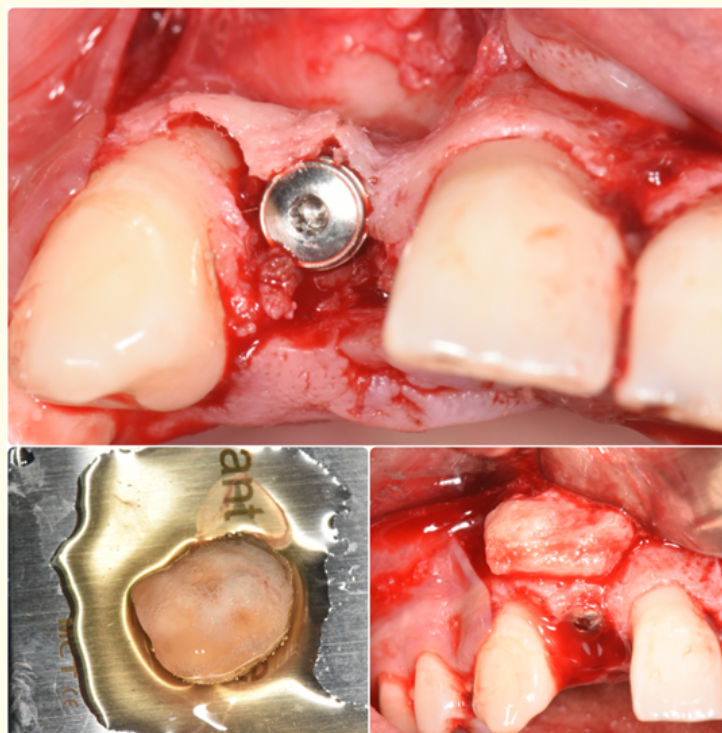


Figure 3

For the left side, SCT was carried out using peizo-surgery followed by ridge expansion using Micro dent expanders till reaching adequate reasonable ridge thickness (Figure 4-a). Unfortunately, after completing the SCT and expansion, there was sever undercut in the bone sub-crestal and sever inclination that will compromise the implant placement (Figure 4-b). Upon that we decided to postpone the implant insertion and augment the deficient ridge by de-cortication and sticky bone use (Figure 4-c). Using those steps, the left side was managed by two stages SCT.

Flap closure was done using interrupted suturing “4/0 vicryl” (Figure 4-d). For postoperative management, medications were prescribed, including chlorhexidine rinses three times a day, 1g amoxicillin (2 times daily for 6 days, ibuprofen (400 mg) 4 times daily unless medically contraindicated, and pain medication as needed for pain. Patients were not allowed to use any removable prosthesis.

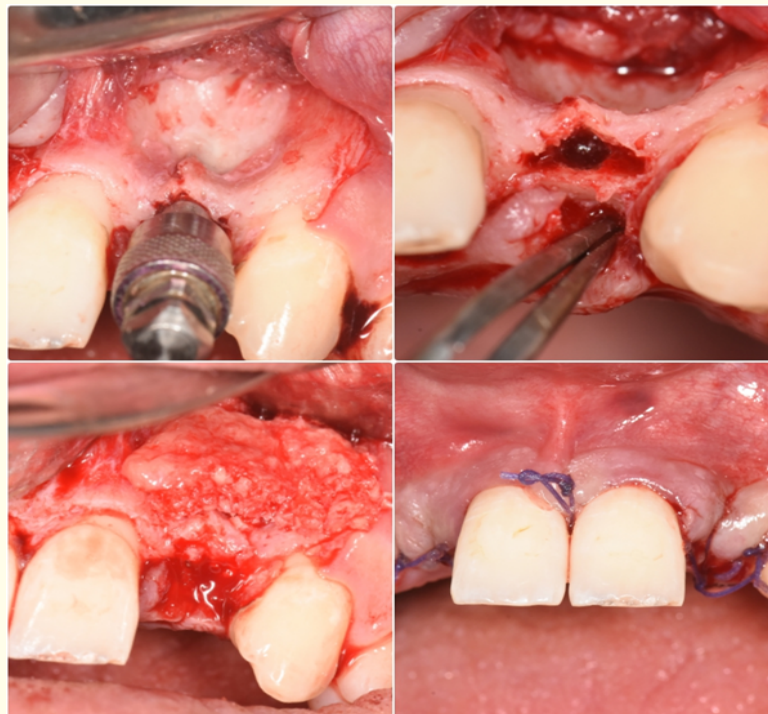


Figure 4

After three month, clinical and radiographic evaluation “using CBCT” was carried out, which revealed excellent soft tissue healing (Figure 5-a and b) and radiographic evidence of bone fill were recorded above the augmented area bilaterally. For the right side, the ridge thickness reached 5.68 mm crestal, while the left side recoded 4.52 mm crestal and 5.87 mm sub-crestal (Figure 5-c and d).

Concerning the left side, re-entry was done (Figure 6-a) and bone expansion of the regenerated bone was carried out (Figure 6-b). Implant placement was done, with slight crestal bone dehiscence (Figure 6-c), which was managed by sticky bone “orthrosera bone albumin allograft” (Figure 6-d).

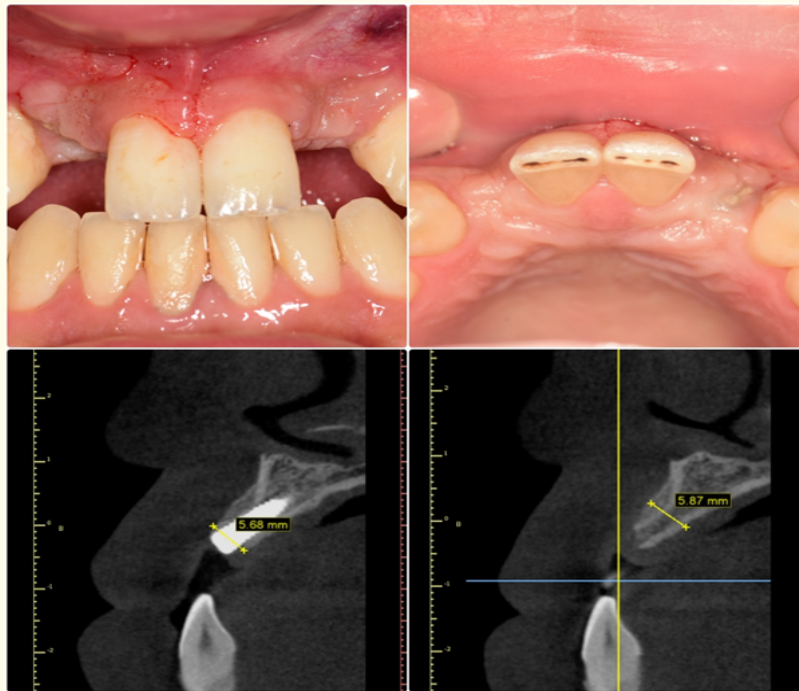


Figure 5

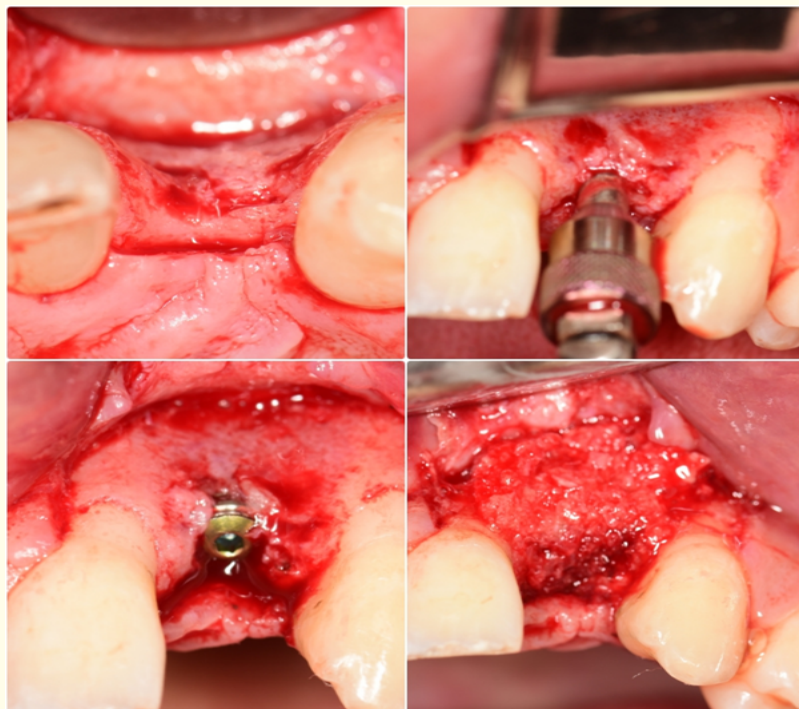


Figure 6

Discussion

Rehabilitation of partial or total edentulous area with dental implants has been considered as a predictable treatment option with high success rates. However, insufficient width of the alveolar ridge due to atrophy, periodontal disease or trauma may compromise implant placement. 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 [16].

Compared with guided bone regeneration or block grafting, the ridge splitting technique enables 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 [17-19]. On the other hand, this technique can be used for horizontal deficiencies, but not for vertical augmentation. Furthermore, the ridge splitting technique requires a minimum of 3mm of bucco-palatal 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 [20,21].

The alveolar SCT might increase bone width and the possibility of implant placement. However, it is so hard to predict the total thickness of bone gain after using this technique in horizontally resorbed ridges, as any thickening of the alveolar ridge has been considered successful. The SCT was effective regardless of the surgical instruments used. Furthermore, an average gain of 3.8 mm in thickness of the alveolar ridge can be expected [22].

Interestingly, the greatest increase in the alveolar ridge thickness was gained with splitting of maxillae. Several studies confirmed these results which conclude that the division of the maxillary bone crest is obtained with relative ease due to bone characteristics (types III and IV) and due to the higher vascularization of the maxilla [2,4,13-23].

Many studies with implant installation during the SCT, this one-stage surgery is almost always possible, were conducted, since primary stability is achieved mainly from the apical bone division. Additional benefits of implant placement include a shortened time between the first surgery and prosthetic treatment. Furthermore, immediate implant insertion requires lower amounts of biomaterials, reduces costs, and also prevents the collapse of the expanded cortical walls. Finally, it also results in less discomfort for the patient, who will undergo only one surgical procedure [5].

Scarano., *et al.* recommended the two-stage technique with conventional loading of the implants, since this might prevent unplanned fracturing of the vestibular wall, reducing complications and obstacles to treatment [24]. In contrast, Shibuya., *et al.* stated that even if a malfeature occurs, a sufficient volume of alveolar bone can be obtained using a free bone segment without rigid fixation. The authors also mentioned that dental implants placed within the malfeature area show a good prognosis [25]. Demetriades., *et al.* found no differences between osseointegration applied in one or two stages [26].

Different surgical instruments have been used successfully for the creation of space between cortical crests. With respect to this criterion, the highest average gain in thickness of the alveolar ridge was 5.6 mm, using a piezoelectric surgery device (US instrument) [23].

When hand instruments are used, they are pressed against the bone with precise and gentle hammer blows. The use of conventional surgical instruments is more time-consuming than the use of piezo-surgery instruments and requires greater technical skill. By comparison, rotational instruments are faster, but the soft tissues such as the tongue, cheek, and lips may be injured. In addition, these instruments are difficult to handle when adjacent teeth are present, due to the angle required [27,28].

In comparison to rotary instruments, US devices show practical clinical benefits such as (1) reduced noise and vibration (2) reduced psychological stress, (3) no risk of soft tissue injury, and (4) ease of horizontal and vertical bone incisions without damage to the adjacent structures. In addition, these instruments offer better visibility during the procedure since they keep the work area clean [29,30]

It is noteworthy that the biological viability of bone tissue treated with piezo-surgery is comparable to that of bone that has been subjected to cutting by other surgical techniques. Osteotomy with piezo-surgery devices seems to be beneficial during the early stages of bone healing. Larger amounts of bone morphogenetic proteins seem to be introduced at the beginning of the healing process, reducing inflammation and stimulating bone remodelling [27]. The use of bone grafts between cortical walls did not significantly influence the bone volume gain. However, more studies are necessary to confirm this finding.

Conclusion

Compared with guided bone regeneration or block grafting, the ridge splitting technique enables implant placement, eliminates the need for bone harvesting and reduces a risk of graft or membrane exposure. The two-stage technique of ridge splitting with conventional loading of the implants is much better than one-stage in severely deficient alveolar ridge, since this might prevent unplanned fracturing of the vestibular wall, reducing complications and obstacles to treatment.

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