ABSTRACT

A trophied premaxilla is considered one of the most problematic areas for rehabilitation with implant due to diminished ridge width and/or length. Using of ridge splitting technique is one of the conservative surgical procedures that can be done under local anesthesia to increase the width of alveolar ridge. Materials & methods: Fourteen partially edentulous patients of both sexes were selected for this study with missing upper central or lateral incisors with proper bone height at the edentulous area (the average length was 13 mm) and resorbed bucco-lingual width (average bucco-lingual width was 3:4 mm) as indicated from ridge mapping and computed CT scan. Patients were divided into 2 groups. In Group one, ridge splitting was done using closed technique while in Group 2 ridge splitting was done using open technique, splitting was followed with simultaneous implantation in both group. Result: Increasing of bone width were achieved in both group with ossoeintegration of installed implants, also the length and width of buccal bone in Group 1 (closed technique) showed statistically significant bone loss in both vertical and bucco-lingual dimension in 4 cases and statistically non-significant change in the other cases. While length and width of buccal bone in the Group 2 (open technique) showed statistically non-significant change along the follow up periods at 12 and 18 months. Conclusion: Open technique of ridge splitting is simple technique that can improve ridge width with simultaneous implantation without postoperative complication.

INTRODUCTION

Osseointegration of dental implants is highly predictable when implants are completely embedded into bone\(^{(4)}\). A minimal amount of surrounding bone is necessary at implant placement. In the horizontal dimension, an optimal minimum thickness of vestibular and buccal surrounding bone lamellae is \(> 1\text{mm}\) \(^{(2)}\).

When the alveolar ridge is narrower than the optimally planned implant diameter, reconstruction of the ridge before implant placement is mandatory, or, removable partial denture is indicated to provide the needs for aesthetics and function. However, limitations to conventional PD, therapy include lack of stability, minimal retention, periodontal compromised abutment teeth and unaesthetic clasps\(^{(3)}\).
There are several surgical techniques available to enhance bone volume for implant placement. These procedures include bone grafting, Guided bone regeneration, and Distraction osteogenesis. These methods have several drawbacks including invasive surgical procedures, resorption of grafting materials, membrane collapse, exposure to infection and delaying of implant installation for grafting maturation.

Expansion of the existing residual ridge is another method to prepare the atrophied maxilla and/or mandible for implant insertion and augmentation. This approach has been referred to as ridge splitting, bone spreading, ridge expansion, or the osteotome technique.

Ridge splitting for root-form implant placement was developed in the 1970s by Dr. Hilt Tatum Summers, who revived the interest in this technique with development of summer osteotomes. This technique depends on splitting the vestibular and buccal cortical tables and further open the space with Summers’ osteotomes; this creates room for implant placement with sufficient surrounding bone.

This technique is only suitable with a minimum ridge width of 3.0 mm, with no vertical bone defect. Ridge splitting is more applicable to the maxilla than the mandible. The thinner cortical plates and softer medullary bone make the maxillary ridge easier to expand. Splitting ridges narrower than 3 mm can result in bone fractures and resorption. In addition, the clinician should avoid attempting ridge splitting when facial bone concavities are present. The bone quality also influences the ability to expand the ridge.

There is more than one approach for ridge splitting either closed or opened technique. Sethi and Kaus evaluated the ridge expansion technique in thin maxillary ridges with adequate height and two cortical plates separated by a cancellous layer of bone. They placed 449 implants at the time of expansion in 150 patients with 97% implant survival rate after a 5-year observation period was found.

Cornelio Blus et al., reported that in 57 patients underwent a split-crest procedure with the aim to place 230 implants, 78 in the mandible and 152 in the maxilla. The 3-year life-table analysis of loaded implants showed a cumulative survival rate of 100% using open technique for ridge splitting.

**AIM OF THE STUDY**

To compare between closed and open technique of ridge splitting followed by implantation in atrophied premaxilla

**MATERIAL AND METHOD**

Fourteen partially edentulous patients of both sexes were selected from Out-patient Clinic, Prosthetic Department, Faculty of Oral and Dental Medicine, Cairo University, their ages ranged from 20 to 40 with an average age of 30 years old.

The selection was according to the following criteria:

- All patients were apparently in good general health, and free from debilitating diseases that could affect or interfere with normal bone healing and osseointegration.

- Patients were selected with missing upper central or lateral incisors with proper bone height at the edentulous area (the average length was 13 mm) and resorbed bucco-lingual width (average bucco-lingual width was 3.4 mm) as indicated from ridge mapping and computed CT scan Fig. (1).
Selected patients were non-smokers, free from T.M.J troubles or abnormal oral habits such as bruxism, clenching. Also cases with deep overbite or marked over-eruption were excluded. The remaining natural teeth had apparently good periodontal condition with the opposing occlusion in the lower jaw was either dentulous or edentulous.

2- Grouping

Patients were divided into two groups according to the technique of ridge splitting

- **Group 1:** Ridge splitting was done using closed technique without flap opening.
- **Group 2:** The same as in group 1, but full thickness muco-periosteal flap was reflected at the area of implantation.

Preoperative panoramic radiographs were used to ensure adequate bone height for implant placement. Palpation of the bone and ridge mapping were made to ensure that remaining bone width was not less than 4mm as confirmed with CT-scan.

3- Procedures

Upper and lower casts were mounted on articulator for each patient. Waxed try in setting up of teeth was made and tried inside patient mouth. This was used latter on for fabrication of surgical template to ensure proper alignment of installed implant regarding adjacent teeth and opposing occlusion Fig.(2).

**Implant installation**

**Group (1)**

Patients were treated under local anesthesia. Crestal incision was done through keratinized mucosa down to the bone. A round-handled scalpel with a No. 15 blade was used to begin the osteotomy. The osteotomy should bisect the ridge crest and separate the cortical plates. This could be done by changing the blade more than one time. A mallet was used to advance the scalpel blade through the bone. The handle of the scalpel should parallel the palatal or lingual cortex. This path will often result in a more facial angulation of the handle than the ideal long axis of the teeth. After the scalpel blade is tapped to depth, it should be gently removed with a back and forth motion, parallel to the cut, to prevent breakage of the instrument, or labial bone cracking Fig.(3).

Crestal bone cut was made to within a millimeter of an adjacent tooth. The length of the osteotomy along the edentulous span should extend well beyond the planned implant sites. This extended length will allow the plates to expand or bow during preparation of the osteotomy and implant insertion. After the crystal osteotomy with the sharp lancet is completed, then thin graduated bi-beveled chisels was used to separate the cortices and begin the ridge expansion. In dense bone, a thin, tapered fissure bur or a saw blade is often preferred to complete
the bony cut. If possible, the depth of the osteotomy should be extended beyond the planned length of the implant, which will allow a hinging of the bony plates at the base of the ridge split osteotomy. Implant site preparation can be accomplished using round, tapered osteotomes or implant drills guided by the surgical template. Careful insertion of the implant (or implants) should be performed to slowly expand the ridge and accommodate the implant diameter. Tapered implants of 3.75mm diameter were used because they demand less expansion at the base of the osteotomy and allow more gradual bone expansion during implant advancement. Following implant insertion, sutures were made on both sides of installed implant to ensure primary closure of the soft tissues over the ridge crest. Adequate implant healing periods were necessary (6 months) to allow regeneration of the bone between the separated plates.

- **Group (2)**

The same procedures were followed as in group 1, except the followings:

- Full thickness mucoperiosteal flap was reflected extending one tooth before and after the edentulous area. Two vertical osteotomy cuts were made 2mm away from adjacent teeth. Then the same procedures of expansion were followed as in group 1 Fig. (4, 5, 6).

Serial CT-scans were made for every patient at 6, 12, 18 months postoperatively to trace the change in both bone height and width around installed implants Fig. (7).
RESULTS

Increasing of bone width were achieved in both group where, the average bone width was 3-4mm in both group at the crest of the ridge preoperatively and increased to (6mm) in Group 1 and (7mm) in Group 2 as measured by bone caliper.

Of the 14 implants seven in each group, one could not be placed in Group 1 because of cracking of the internal table in the maxilla also, fractured of buccal plate of bone was done in two cases in Group 2 during expansion. In Group 1 the flap were closed on the cracked bone to heal without implantation. While in the 2 cases of Group 2 the buccal bone plates were fixed in its position using 2mm screw of 4mm length using lag technique to prevent resorption of the buccal bone, followed by reposition of the flap without implantation.

Six implants in Group 1 and five implants in Group 2 were inserted smoothly in each group after ridge splitting with preservation of the surrounding cortices without surgical complications. During follow up period that extend for 18 months no complication was detected in both group.

Postoperative CT scan (axial, coronal and sagittal) showed that proper ossoeintegration was done for all implants in both group with formation of bone on the mesial, distal, buccal and palatal interface, where the cumulative survival rate of loaded implants was 100%. Fig. (7).

The length and width of buccal bone in the Group 2 (open technique) showed statistically non-significant change along the follow up periods. While the length and width of buccal bone in Group 1(closed technique) showed statistically significant bone loss in both vertical and bucco-lingual dimension in 4 cases and statistically non-significant change in the other cases.

While, bone density in both groups showed statistically gradual increase along the total follow up period.

TABLE (1) change of bone height along different time intervals

<table>
<thead>
<tr>
<th>Group</th>
<th>Period</th>
<th>Mean</th>
<th>SD</th>
<th>Period comparison</th>
<th>P-value</th>
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<td>0.188</td>
<td></td>
<td>6-12 month</td>
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<tr>
<td></td>
<td>18 months</td>
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<td>12-18</td>
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<td>18 months</td>
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<td>0.239</td>
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</table>

DISCUSSION

The split-crest procedure in combination with immediate implant placement has been described more than 10 years ago(7,8). Using of ridge splitting for expansion of narrow ridge eliminates the need for onlay grafts taken from the hip, the maxillary tuberosity, the symphysis of the chin or the external oblique ridge. Moreover, it avoids the use of a secondary surgical site that exhibits postoperative morbidity associated with bone harvesting. An additional advantage of the procedure is that immediate implant placement shortens the treatment
period and reduces the costs. All factors that enhance success of this technique were taken in consideration, regarding, patients selection, determination of bone width, and following the protocol of ridge expansion strictly and gently.

In Group 1, only crestal incision without flap reflection was made to ensure intact periosteum coverage for the expanded bone plates with sufficient blood supply. Sharp lancet was used to facilitate splitting procedures and avoid ridge cracking or labial plate fracture. On the same way, thin bi-beveled graduated chisel was used gently and slowly to ensure gradual ridge expansion without cracking or bone plate fracture. Preoperative ridge mapping was so important, not only for recording ridge width, but also for helping in control the direction of force application during expansion procedures. Surgical template was used to control the direction of implant drilling as well as implant insertion to avoid changes that may occur in sagittal inclination of installed implant during installation, hence, the receiving implant bed was splitted.

In Group 2, open flap technique aimed to provide better accessibility, visibility as well as, controlling on surgical procedures. Open technique ensure exact position of splitting procedure without encroachment of labial or palatal bone plates that may occur with closed technique.

The two vertical osteotomy cuts (2mm away from adjacent teeth) helped to maintain splitting effect to the edentulous area without encroachment of bone covering adjacent teeth. The three cases excluded in this study were due to cracking of bone plates. This may attributed to the original stiff non-resilient bone in operative area. A condition that cannot be evaluated; except, during the surgical procedures. Also, this may attributed to, mal-orientation of the chisel during expansion or due to excessive forces used during hammering on the chisel.

The main goal that has been achieved with ridge splitting was the gain of bone width with simultaneous implants insertion and integration in both groups. This success was explained by Misch, as the wound healing in these cases of ridge splitting is similar to the fracture repair of bone [14]. The gap fills with a blood clot that organizes and is replaced with woven bone. This immature osseous tissue develops into load-bearing lamellar bone at the implant interface with proper osseointegration. Scipioni et al., showed that with ridge splitting, an average increase in ridge width from 2.4 to 6mm could be achieved, they also found that the interproximal marginal bone healed to the level of the roughened titanium plasma-spray surface on the implants. The amount of direct bone contact to the implants along the mesial and distal surfaces was similar to the buccal and lingual surfaces that approximated the adjacent cortices. (15)

Cracking and fractured of buccal bone during ridge splitting are considered of great complication for ridge splitting either with open or close technique, which could occur due to denser inflexible cortices or treating very thin ridge. Therefore, consequences of failure can be more detrimental with ridge splitting compared with guided bone regeneration or onlay bone grafting. (15)

Although, the non-reflected muco-periosteal flap maintain good blood supply of buccal cortex in Group 1, the statistically significant buccal bone loss both vertically and horizontally during the follow up periods in this group may be due to the blind ridge splitting with closed technique that leave small thickness of buccal cortex that showed resorption due to normal cervical stresses of loaded implants. This was not the same for Group 2 (open technique) where, more accessibility and visibility were achieved. This coincides with the disadvantage of ridge splitting in which complications may arise and bone loss may occur. Therefore, proper case selection and surgical technique is important when considering the use of ridge splitting techniques.(16)

**Refrence**


