Modified ridge splitting and bone expansion osteotomy for placement of dental implant in esthetic zone

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Abstract

Ridge splitting with bone expansion is a technique of manipulation of bone to form receptor site for implant without removing any bone from the implant site. Maxillary bone has inherent quality of flexibility which can bemolded to desire location by using series of instrument namely chisels and osteotome. This further improves quality of bone all around implant, at the crest and apex both. This article describes a report of a clinical case with management of bucco-palatal ridge defect with modified ridge splitting and expansion osteotomy technique using chisel and osteotomes in an esthetic zone.

Keywords: Bone expansion, bone manipulation, horizontal ridge defect, ridge split

Introduction

The availability of adequate bone volume for dental implant placement in esthetic zone is often diminished by tooth loss associated with trauma in many young healthy individual. Loss of bucco-palatal dimension of ridge further necessitates calls for additional procedure to receive optimum implant borne prosthesis. Management of such defect becomes still critical in esthetic zone. Lateral augmentation with autogenous bone and guided bone regeneration (GBR) and bone-expansion (bone-splitting) techniques have been adopted for management of bucco-palatal horizontal ridge defect successfully. It is well-established that the implant placement must be prosthetically driven and not bone.[1] If one fails to achieve necessary modification in bony defect prior implant placement then esthetic and may be functional failure is inevitable.[1]

Ridge augmentation using autograft and block graft,[2] GBR using membrane[2] have proved to be successful in highly resorbed ridges to achieve result in horizontal and vertical dimension but several drawbacks including invasiveness, additional donor site, resorption of grafting materials, memberane collapse and exposure to infection and delaying of implant installation for grafting maturation. Hence, employing such traumatic technique in moderate horizontal ridge defect (≥3 mm) is not necessary. More noninvasive technique of ridge splitting and expansion can be carried out easily, without much trauma to the patient.

When the bucco-lingual bone width is 3 mm or greater but <6 mm, to allow implant placement, augmentation of the alveolar ridge using a ridge splitting and bone expansion technique is a viable option. The 3 mm of bone should have at least 1 mm of trabecular bone sandwiched between the cortical plates. That will ensure 1.5 mm of bone (cortical and cancellous) on either side of the split ridge and allow the bone to spread and maintain a good blood supply. Several ridge split techniques have been developed in past few decades and includes split crest osteotomy,[3,4] Ridge expansion osteotomy,[5] and numerous modification it.

Summers (1994) advocated use of osteotome in progressively increasing diameter to create osteotomy bed for implant placement during same stage.[6] Maxillary bone is softer in quality (mainly D2, D3 and D4 type). Failure rates of implant placed by mere drilling are very high in maxilla.[7] The use of osteotome allows manipulation and compaction the peri-implant bone to achieve excellent primary stability without losing any bone.[6] However, some authors claims certain bone loss associated with use of osteotome to achieve bone expansion.[8] The possible reason being stress concentration at the crest while progressing the osteotomy to wider diameter.

This article describes a technique of modification of ridge split bone expansion osteotomy done using osteotomes and chisels in narrow ridge. The alternate use of osteotomes and chisels relieve the stresses at the crest by extending a chisel cuts

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slight mesial and distal to osteotomy. Unlike segmental ridge splitting, no attempts are made to give vertical osteotomies cuts. Thus, this case report explains a technique of modified ridge split bone expansion osteotomy with simultaneous implant placement in maxillary esthetic zone.

Case Report

The present case report is about a 19-year-old Indian male patient reported with chief complaint of disliking his maxillary anterior removable appliance. He requested a fixed prosthesis, preferably an implant-supported one. The medical/social and family history was noncontributory. Patient gave history of trauma and exfoliation associated with tooth no. 11 5 years back [Figure 1a]. Extra- and intraoral examinations were within normal limits and his dentition was in a good state of repair.

The clinical examination of alveolar ridge and soft tissue revealed thick gingival bio-type. There was a buccal defect on alveolar ridge in relation tooth no. 11 due to trauma and probably by pressure exerted from the removable appliance [Figure 1b]. Furthermore, slight mesial drifting of tooth no. 21 was noted.

Radiographic Investigation

The periapical X-rays revealed adequate bone height and mesio-distal bone width. However, periapical and panoramic radiographs allow visualization of only two dimensions. However computed tomography (CT) scan allows visualization of bucco-lingual (third) dimension, in addition to the other two. The CT scan revealed 3.2 mm of bucco-lingul width of ridge, with presence of 1.5 mm to 2 mm of cancellous bone within initial 4 mm height of crest. The width of bone increased gradually in apical direction [Figure 2]. There was adequate cortical and cancellous bone to allow ridge split and expansion procedure.

Treatment

The treatment was divided in three steps namely:

Surgical technique

Pre-operative antibiotics and analgesic were prescribed and the patient was prepared in a sterile environment. Local anesthesia lignocaine 2% containing 1:80,000 adrenaline was injected in the area of surgery as an infiltration. A papillary sparing crestal incision was given and combined muco-periosteal and mucosal flap was reflected on labial aspect and only mucoperiosteal flap on palatal side. The combined flap provides advantage of proper flap closure after ridge expansion. The exact location of implant on the ridge was marked by an indentation created by surgical blade. Three types of ridge expanding instruments namely, uni-beveled chisel, bibeveled osteotome and tapered osteotomes were used in the surgery. All these instruments were used by gentle tapping with mallet.

Using uni-beveled chisel (2 mm), with bevel facing labial side, an indentation made on crestal cortex was perforated to reach cancellous bone. If the crestal cortical is very thick and one still finds difficulty in perforating it then a 0.5 mm width diamond disc cutter can be used but no ditch with round bur are made to preserve maximum bone in bucco-lingual dimension.

The bi-beveled osteotome 2.5 mm, 3.5 mm in length and tapered osteotome 2 mm, 3 mm diameter at the tip were used alternately to expand the osteotomy. The Figures 3a-g shows a schematic presentation of technique in cross sectional view.

All the instruments after tapping to desired depth were wiggled back and forth in a mesio-distal direction with slight buccal pressure. This allows expansion of ridge facially with advancing osteotomies as well as easy removal of instrument without any risk of fracturing the labial plate.

Any crestal resistance if felt before reaching desired depth was relieved by advancing chisel cut mesial and distal to osteotomy. It was done using uni-beveled chisel. This chisel cut extension allowed better relieving of stress concentrated at the crest during ridge expansion with osteotome. Similarly, any apical resistance if felt was relieved by the smallest diameter pilot drill by untouching the crestal bone. The final instruments closely matched the shape of the implant. Slef tapping, threaded, cortex-saturn implant 3.7 mm × 11.5 mm implant was carefully placed in expanded osteotomy at same surgical appointment. It is advisable to place bone graft and membrane in adjacent chisel cut area if it is more than 2 mm

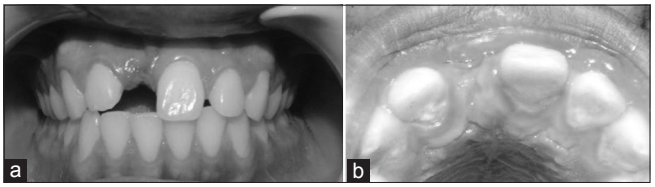

Figure 1: (a) Pre-operative front view. (b) Pre-operative occlusal view. Note horizontal deficient ridge at 11 region

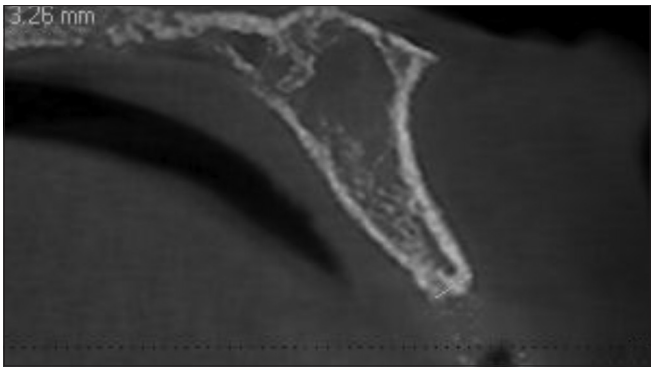

Figure 2: Cross sectional image showing 3.2 mm width at crest

wide. However, in this case no bone graft and membrane were required. The clinical images of the case have been explained in [Figure 4a-f]. The expanded ridge with an implant shows healthy amount of peri implant bone at crest [Figure 4f] and appropriate flap closure.

This technique if done skillfully and carefully can be helpful to expand and remove labial undercuts, which are major causes of fenestration during implant placement. This will also prevent off-axis loading.

Second stage surgery

Labial frenectomy was carried to relieve tension on papilla between tooth no. 11 and 21 8 weeks after surgery. Thereafter healing period of 4 weeks, implant uncovering surgery was performed with palatal roll technique [Figure 5a].[9] This allowed shifting of crestal soft-tissue on labial aspect. Patient was recalled after 3 weeks for impression making. The healed gingival collar around implant showed healthy peri-implant keratinized mucosa [Figure 5b]. Note use of tissue punch in esthetic zone for implant uncovering is highly unacceptable.

Implant restoration and laminates

An implant level indirect impression was taken with a closed tray technique after placing of an implant transfer post. Heavy body polyvinyl siloxane impression material was used for the impression. The implant transfer post was attached to the implant analog before it was snapped back into the impression. The laboratory poured cast with gingival mask and fabricated all-ceramic crown with 25° titanium abutment.

During prosthesis coping trial, tooth no. 21 was prepared to receive ceramic veneer and 22 and 12 were prepared with composite veneers. Implant crown and veneer final trial was taken and cemented [Figure 6]. Any excess cement around implant crown and laminates were removed meticulously.

Final outcome and follow-up

The final esthetic outcome with pre-operative [Figure 6] and post-operative smile after 1 year shows esthetically satisfactory result. The post-operative X-ray after 1 year shows very minimal bone loss at crest [Figure 7].

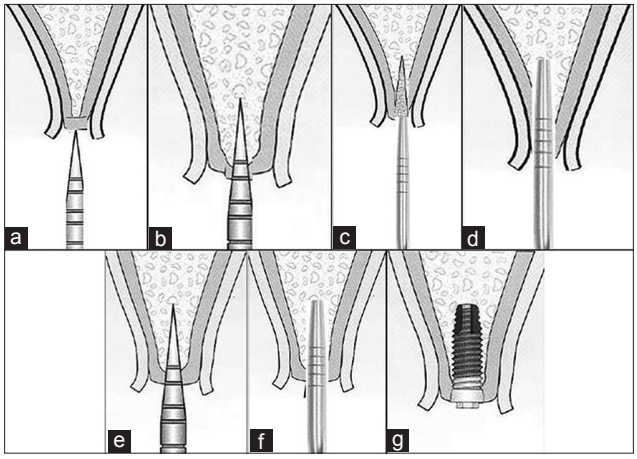

Figure 3: (a and b) Use of smaller length bibeveled osteotome to achieve lateral expansion of ridge. (c and d) Use of smallest diameter tapered osteotome in an osteotomy created by bibeveled instrument to achieve further lateral expansion. (e and f) Use of progressively increasing bi-beveled osteotome and tapered osteotome in an osteotomy created by previous instruments. (g) Ridge after dental implant placement

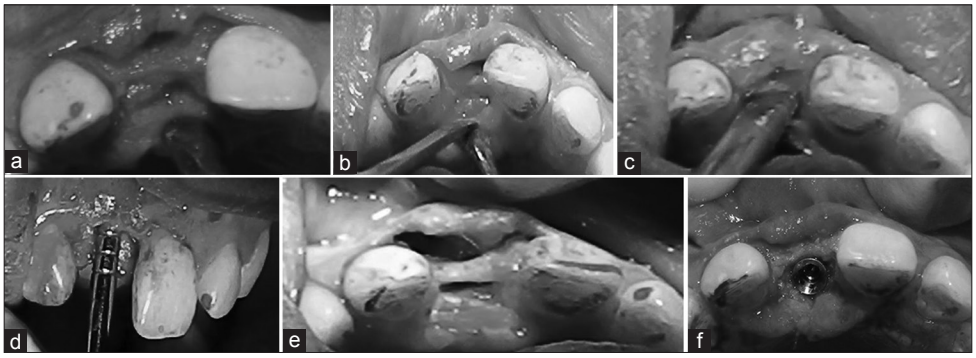

Figure 4: (a) Pre-operative width at the crest. (b) Use of unibeveled chisel to perforate cortex. (c) Use of bi-beveled osteotome to initiate splitting and expansion laterally. (d) Tapered ostetome use to progress osteotomy. (e) Crest after ridge splitting. (f) After implant placement

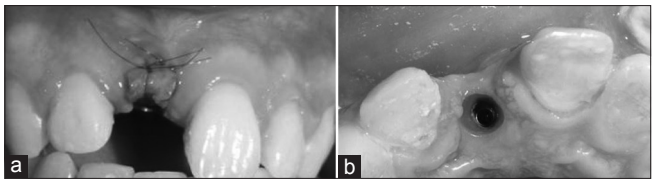

Figure 5: (a) After 2nd stage surgery with palatal roll technique. (b) Note healthy peri-implant keratinized tissue

Figure 6: Final outcome

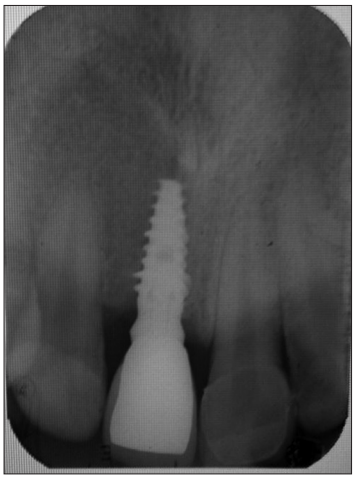

Figure 7: Post-operative X-ray after 1 year

Discussion

It is well-established that alveolar ridge <5 mm requires augmentation procedure in order to receive endosseous implant with healthy peri-implant bone of 1.5-2 mm. If implants are placed in areas of inadequate ridge width then following problem can occur.[10]

- Dehiscence of labial bone predisposing chances of peri-implantitis, leading to unesthetic metal display through gingiva
- Leaving a thin bone <1-1.5 mm may predispose to resorption of thinner labial plate in near future, meeting gingival recession and implant exposure
- Undercuts present on alveolar bone gives rise to off-axis loading.

All these problems can be overcome by augmenting bone either through grafting or by other means. Various treatment options to managed horizontally deficient ridge include increasing width by osteoplasty, using narrow diameter implant, ridge augmentation by autogenous block graft, corticocancellous particulate bone graft and allograft using GBR membrane, distraction osteogenesis and ridge splitting with bone expansion techniques, etc.

Increasing width with osteoplasty results in FP2 and FP3 prosthesis. Narrow diameter implant presents greater mesial and distal cantilever, thus higher tendency of fatigue fracture with abutment and its screw loosening.[11] Ridge augmentation with bone block and GBR technique carries additional donor site, long term waiting period 6-12 months, risk of membrane exposure infection and increase cost to patient without 100% success rate.[12,13] Distraction osteogenesis leaves patient uncomfortable and is cumbersome.[14]

Although ridge splitting and bone expansion appears to be technique sensitive but has many advantages over different technique.[5,6] It takes advantage of inherent quality of flexibility of cancellous bone. Maxillary bone is pliable and can be slowly manipulated to improve quality (compaction and corticalization) and expanded to desired width. When clinicians allow times for manipulation of bone, it can eventually mold to desired location. It never allows loss of patient bone which is usually unavoidable by mere drilling procedure.[15] The success of this technique also depends on maintaining integrity of labial bone, which occurs as long as periosteum is intact. Periosteum due to its elastic nature allows bone expansion and manipulation and acts as a barrier membrane and makes micro-fracture heals very well because of intact blood supply. Hence it is advisable to leave intact periosteum encasing the bone which can achieved by raising conservative muco-periosteal flap in area of implant placement and then further mucosal flap to coronally advance flap closure.

The ideal indications of ridge splitting and bone expansion procedure are those sites that do not require vertical ridge augmentation and having cancellous bone present between labial and palatal cortical plate. It can be best done in a narrow ridge of minimum 3 mm with greater preference in maxillary bone over mandibular.

The technique of ridge expansion osteotomy developed by summers uses sequence of progressively increasing osteotome to create an osteotomy closely receptacle to implant dimension.[5,6] Though this technique provides atraumatic approach for bucco-lingually deficient ridge but Padmanabhan and Gupta demonstrated greater crestal bone loss associated with osteotome technique compared to conventional technique.[8] However they made no attempt to relieve stresses at crest associated with the use of oseotome. The extension of chisel cut mesial and distal to osteotomy prevents stress concentration at the crest and thus crestal bone loss.

The technique present in this article works satisfactorily well in maxilla bone compared to mandible. Since maxillary bone is more porous, mainly D2, D3 and D4 type bone can be manipulated to desired location. However, mandibular bone presents mainly D1 and D2 quality, thus poses greater difficulty with bone manipulation.

Several authors advocated different ridge split technique,[3,4] in which crestal cut osteotomy is joined to adjacent vertical osteotomy cut on either or on both side followed by creation of greenstick fracture of buccal plate. After the expansion of osteotomy to appropriate size, it is either grafted with bone graft (two step)[16] or implant is placed at same appointment (single step).[17] This technique jeopardizes the blood supply to the fractured buccal plate and hence rate of sequestration is high if not done carefully.

There are several disadvantages to this technique. It cannot achieve vertical bone height, only width is possible. It is a very difficult and operator dependent technique, with a substantial learning curve. And it is more difficult to perform on a single tooth than on entire ridges, where the operator can take advantage of the elasticity of a long ridge of bone.

Sethi and Kaus have reported more than 97% of success rate in two staged implant placed by osteotome through maxillary expansion in a 5 year study.[18]

The author has successfully taken large ridges in the maxilla 3-4 mm wide and expanded them to 5-6 mm wide. If an increase in width in ridges <3 mm wide is desired, other techniques, such as onlay grafting, GBR augmentation, distraction osteogenesis or nerve repositioning must be used.

Conclusion

In this report, there was 3-4 mm of bone crestally, which did not allow implant placement with conventional technique. There was sufficient trabecular bone with cortical bone on either side. This was an ideal case for ridge splitting with bone expansion.

Learning points

1. Use of ridge splitting technique offers great advantage of placing dental implant at same surgical appointment in ≥3 mm of bone width
2. Bone expansion allows condensation of softer bone quality to more condensed variety apical and lateral to prepared osteotomy
3. Since no drilling is required to prepare implant osteotomy. It prevents loss of patient bone associated with drilling
4. Bone expansion also helps to reduce any labial undercut and allows more favorable axial loading
5. Combined flap on labial side maintains integrity of labial bone by preserving intact periosteum over cortical bone.

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