Staged ridge-split evaluated using cone beam computed tomography and peri-implant plastic surgery in the mandibular arch

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ABSTRACT
Lack of sufficient bone to place an implant at a functionally and an esthetically appropriate position is a common problem, especially in the mandibular posterior region. Narrow edentulous alveolar ridges <5 mm wide require bone augmentation before implant placement to establish a bony wall of at least 1 mm around the endosseous implant. Various surgical widening techniques are available, including lateral augmentation with or without guided bone regeneration, ridge-split technique and horizontal distraction osteogenesis. The ridge-split technique aims at creating 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 cortices is filled with a graft material. Peri-implant plastic surgery focuses on harmonizing peri-implant structures by means of hard- and soft-tissue engineering and includes bone structure enhancement, soft-tissue enhancement, precision in implant placement and improves quality of the prosthetic restoration. The rationale for the peri-implant plastic surgery approach goes well beyond pure esthetics as it creates peri-implant keratinized mucosa and interimplant soft-tissue height in order to avoid food impaction, interimplant airflow, and speech problems. This case report demonstrates a staged ridge-split technique evaluated with cone beam computed tomography using a piezosurgical unit and a surgical technique to restore a papilla-like tissue at the time of the second-stage implant surgery.

Key words
Alveolar ridge, cone beam computed tomography, grafting, peri-implant plastic surgery, piezosurgery, ridge-split

INTRODUCTION
Implant therapy success is no longer a measure of implant survival alone, but is gauged by its long-term functional and esthetic survival. Implant placement should be prosthetically driven with correct three-dimensional positioning to allow optimal support and stability of surrounding hard- and soft-tissues.[1]

Lack of sufficient bone to place an implant at a functionally and an esthetically appropriate position is a common problem, especially in the mandibular posterior region. Edentulous alveolar ridges <5 mm in width require augmentation before or at the time of implant placement to establish a bony wall of at least 1 mm around the endosseous implant.[2-3]

Various surgical widening techniques have been described, including lateral augmentation[4,5] with or without guided bone regeneration,[6,7] ridge-split technique[8] and horizontal distraction osteogenesis.[9] The ridge-split technique creates a new implant bed by longitudinal osteotomy of the alveolar bone. The buccal cortex is repositioned laterally by causing a greenstick fracture and the space between the two cortices is filled with graft material.[10,11]

Peri-implant plastic surgery harmonizes peri-implant structures by means of hard-tissue and soft-tissue manipulation. Along with esthetics, peri-implant plastic surgery is also important for creating peri-implant keratinized mucosa and interimplant soft-tissue height in order to avoid food impaction, interimplant airflow, and speech problems.[12]
This case report demonstrates a staged ridge-split technique using a piezo surgical unit and a surgical technique to restore a papilla-like tissue at the time of the second-stage implant surgery.

**CASE REPORT**

A 56-year-old female presented with a chief complaint of missing teeth in the lower right back region and inability to chew food from that side of the mouth. The missing teeth were extracted 5 years back due to dental caries and were never replaced. Cone-beam computed tomography (CBCT), and diagnostic model revealed inadequate bone width for ideal implant placement [Figure 1].

A staged ridge-split followed by implant placement, peri-implant plastic surgery, and prosthetic rehabilitation was planned.

**Surgical technique**

Stage 1: [Figure 2] Crestal and intracrevicular incisions were made around the buccal aspect of teeth, adjacent to the edentulous space to raise a mucoperiosteal flap, exposing the buccal aspect of the mandible. Care was taken to keep the lingual periosteum attached to the bony surface. Using a piezosurgical device, a crestal corticotomy cut was made in the alveolar ridge. On the mesial and distal ends of the corticotomy, vertical cuts were made on the buccal cortex. The length of the vertical cut was determined according to the height of the implants to be placed. The vertical cuts were connected to each other at their caudal ends with a horizontal corticotomy. All corticotomies were 3–4 mm in depth making sure only the cortical bone was affected without significantly affecting the cancellous bone. The mucoperiosteal flap was repositioned and sutured. Suture removal was done after a week.

Stage 2: This was carried out 6 weeks after stage 1. It included splitting of the ridge and lateral mobilization of the pedicled buccal bone. A crestal and intracrevicular incision was performed around the lingual aspect of adjacent teeth to raise a full thickness mucoperiosteal flap. Buccal periosteum was kept attached to the buccal cortical plate to maintain the vascular supply to the previously pedicled bone. Gradual lateralization of the buccal segment was performed using a series of chisels in the increasing order, causing a greenstick fracture at the base of the buccal cortex until a gap of around 5 mm was established between the bony plates [Figure 3]. The space between the cortices was filled with hydroxyapatite synthetic graft material (Bio-Oss, Geistlich Pharmaceuticals, Wolhusen, Switzerland) [Figure 4].

![Figure 1: Preoperative cone beam computed tomography](image1)

![Figure 2: Stage 1 corticotomy](image2)

![Figure 3: 5-mm gap between the cortical plates](image3)

![Figure 4: Gap filled with graft material](image4)
The flap was repositioned and tension free sutures were given using an absorbable suture material (4–0 Vicryl, Ethicon, Inc., Johnson and Johnson, Somerville, NJ, USA). The sutures were removed 1-week postsurgical.

**Implant insertion**

Implants were placed 12 weeks later. A CBCT was made to confirm the increase in ridge width [Figure 5]. Conventional implant osteotomies were performed, and implants (Biohorizons, Birmingham, AL, USA) were placed in the preplanned positions using a surgical stent [Figure 6].

**Peri-implant plastic surgery and prosthetic loading**

The submerged implants were allowed to heal for 12 weeks, after which they were uncovered. In the peri-implant plastic surgery, the attached masticatory mucosa is displaced buccally, thereby increasing the tissue volume on the buccal aspect of the implants. A paracrestal incision [Figure 7] toward the lingual aspect was made to raise a mucoperiosteal flap and gingival formers were attached [Figure 8]. Semilunar incisions were made in the flap at each implant. The first one started distal to the most mesial implant. The tissue was then rotated towards the tongue to create a papilla between the implant and the tooth and between the two implants [Figure 9]. Mattress sutures were given to keep the tissues in place [Figure 10].

Two weeks after the plastic surgery it was seen that bulky keratinized tissue and papilla was regenerated [Figure 11]. At this stage, conventional closed tray impression was made and prosthesis was fabricated keeping the occlusal considerations in mind [Figure 12].

**DISCUSSION**

Various studies have shown that successful osseointegration can be achieved using the two-stage ridge-split technique in narrow alveolar ridges.[13-16] In the mandible, the risk of fracture of the osteotomized segment is high because mandibular bone has less flexibility due to the thicker cortical plates. Thus, widening of the alveolar crest by ridge-split osteotomy should be combined with vertical cuts and a horizontal osteotomy connecting its caudal ends.[10] The apical horizontal osteotomy is the most difficult to control as complete transection of the buccal plate needs to be avoided and is also the most crucial cut as it acts as a hinge for lateral positioning of the fractured segment of bone.[17] Basal greenstick fracture of the segments during widening with osteotomes is difficult to control. Hence, a staged approach to the ridge-split in the posterior mandible was undertaken.

One of the problems in ridge-splitting, using the conventional osteotome technique is the trauma and
eventual fracture of the cortex during separation, causing total detachment and interruption of the vascular supply, ultimately leading to bone necrosis and implant failure. Piezosurgery limits hard-tissue destruction and avoids damage to fine anatomic structures. It also maintains a clear surgical site due to its cavitation effect created by irrigation and oscillation of the tip.

Manipulation of the soft-tissue adjacent to the implants enables proper peri-implant tissue healing and can result in a soft-tissue architecture similar to the healthy gingival anatomy around the teeth.

**CONCLUSION**

Rehabilitation of narrow alveolar ridges with implants placed in three-dimensionally correct positions can successfully be achieved by increasing ridge width using the two-stage ridge-split surgical protocol. Piezosurgery makes the procedure predictable and convenient to perform. The papilla regeneration technique provides enough keratinized tissue in the buccal aspect giving the prosthesis a natural emergence profile and also helps in maintaining adequate hygiene around the implants.

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