Staged Ridge Splitting Technique for Horizontal Expansion in Mandible: A Case Report

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Ridge split procedures are commonly performed for horizontal augmentation of narrow ridges which would otherwise preclude implant placement. A 47-year-old patient with bilaterally edentulous posterior mandibular ridges was treated in the Department of Periodontology and Implantology, M.A. Rangoonwala College of Dental Sciences and Research Centre, employing a "staged ridge split" technique. In this technique, a simple corticotomy at the crestal, apical, and lateral aspects of the buccal cortical plate of the mandible was performed. Following this, a month later, the ridge was expanded and bone graft OssiFi containing biphasic beta-tricalcium phosphate and hydroxyappatite was placed to maintain the gap between the cortices. Thereafter, implants were placed 3 months later. A successful prosthetic rehabilitation was done following a healing phase of 3 months. This approach leads to restoration of function with a predictable outcome and minimal risk of cortical plate fracture during the ridge expansion process.

Key Words: implants, ridge split, ultrasound bone surgery

INTRODUCTION

Dental implants provide a novel method of successful and predictable treatment of partial or complete edentulism. The resorption of alveolar bone is a common sequel of tooth loss and presents a clinical problem for implant placement. Implants must be placed with at least 1 mm of bone on the buccal and lingual aspects in order to maintain crestal bone levels.[1]

Narrow edentulous ridges less than 5 mm wide present a challenge to the clinician for implant placement. Hence, lateral bone augmentation procedures are necessary. These procedures involve the use of bone grafting with different types of grafts (autografts, allografts, xenografts, or bone substitutes), guided bone regeneration (GBR) alone or in combination with grafting procedures,[2,3] as well as the use of ridge expansion techniques utilizing split ridge osteotomy[4] and horizontal distraction osteogenesis.[5]

The ridge split technique consists of splitting the vestibular and buccal cortical tables[6] and further opening the space with osteotomes.[7] Splitting is classically performed with chisel and hammer[8] or with rotating[9] or oscillating saws.[10] Use of a bone chisel is traumatizing and stressful to the patient. Rotating and oscillating instruments increase the risk of damaging the gingiva, the lips, or the tongue.

Ultrasonic bone surgery (USBS) represents a novel alternative technique for bone surgery.[11] Ultrasonically moved knives have the ability to cut hard tissues, such as teeth and bone. In contrast, soft tissues such as gingiva, blood vessels, nerves, and sinus membranes are preserved from injury because they vibrate with the knife tip. In the mandible, there is a higher risk of bone fracture, as

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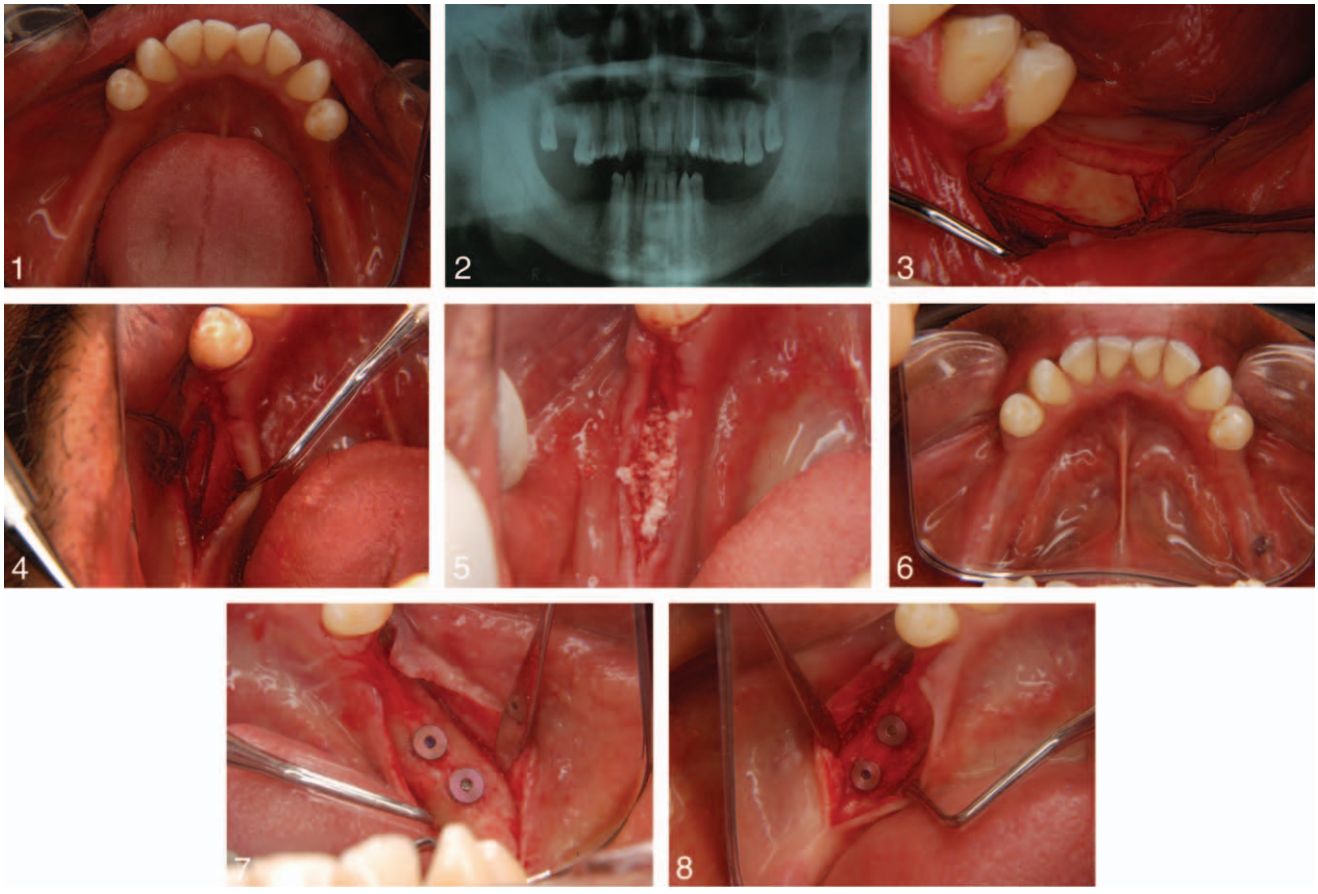


Figures 1–8. Figure 1. Preoperative occlusal view showing inadequate width of the ridge bilaterally. **Figure 2.** Orthopantomogram. **Figure 3.** Stage I – Corticotomy with crestal, vertical, and apical horizontal cuts. **Figure 4.** Stage II – ridge split after 1 month. **Figure 5.** Bone graft (OssiFi) placed. **Figure 6.** Postoperative occlusal view showing 3 mm increase in width of ridge bilaterally. **Figures 7 and 8.** UniTi implants placed within sound bone and excellent ridge expansion can be appreciated.

the bone is less flexible because of thick cortical plates. A staged ridge splitting approach using piezosurgery is presented in this case report.

Case Report

A 47-year-old male patient reported to M.A. Rangoonwala College of Dental Sciences and Research Centre in Pune, India, with a chief complaint of missing teeth. The patient was a nonsmoker and did not present with any relevant systemic history. The teeth in the mandibular posterior region on both sides were extracted due to caries 6 years ago (Kennedy's Class I). On clinical examination of teeth, Nos. 18, 19, 20, 29, 30, and 31 were missing. The clinical picture and CT scan data revealed that the width of the alveolar ridge was 5 mm, inadequate for implant placement (Figure 1). However, the height of alveolar ridge was 15 mm, which was adequate (Figure 2). Routine blood investigations revealed that all the values were in the normal reference range. A staged ridge split procedure was planned for horizontal augmentation for implant placement.

Stage I: Corticotomy

The first step involved a simple corticotomy at the crestal, apical, and lateral aspects of the buccal cortical plate. A full thickness mucoperiosteal flap was raised after crestal and intracrevicular and vertical incisions. The lingual periosteum was kept intact to ensure unhindered blood supply to the bone.

A piezosurgical unit (OSADA, Tokyo, Japan) was used at the power setting of 9 for the corticotomy. Crestal corticotomy was performed with the help of a flat tip up to the medullary bone. On the proximal and distal ends of the crestal corticotomy, vertical

cuts were made on the buccal cortical plate. The apical ends of the vertical cuts were joined by a horizontal corticotomy. The depth of both vertical and horizontal corticotomy was 3–4 mm so that the entire buccal cortex was penetrated. Thus, the Stage I surgery remained confined to the cortical bone without affecting the cancellous bone (Figure 3).

The mucoperiosteal flap was sutured back with 4-0 black braided silk sutures. Routine postoperative instructions were given. A nonsteroidal anti-inflammatory drug (ibuprofen 400 mg) was prescribed tid for 5 days. Chlorhexidine (0.2%) mouthrinse was prescribed for a period of 15 days. Patient was recalled after 1 week for suture removal. The same procedure was carried out on both sides.

Stage 2: Ridge splitting and expansion

After a period of 4 weeks, the second step of ridge split and expansion was performed. A crestal incision was made only to expose the crest of the ridge. A mucoperiosteal flap was not raised in order to maintain the periosteum onto the bone. The ridge splitting was carried out with the help of series of chisels until a gap of 7–8 mm was obtained. Ridge expansion was done after green-stick fracture of the base of the cortical segment (Figure 4).

Bone graft (OssiFi, Equinox Medical Technologies, Amersfoort, Netherlands) was placed in the expanded ridge (Figure 5). The bone graft contained a combination of biphasic ß tricalcium phosphate and hydroxyapatite. The mucoperiosteal flap was sutured back with 4-0 black braided silk sutures. Routine postoperative instructions were given. A nonsteroidal anti-inflammatory drug (ibuprofen 400 mg) was prescribed tid for 5 days. An antibiotic (amoxicillin 500 mg) was prescribed three times a day for 5 days. Chlorhexidine (0.2%) mouthrinse was prescribed for a period of 15 days. Patient was recalled after 1 week for suture removal.

Stage 3: Implant placement

Implant placement was delayed for 3 months after Stage 2 ridge split surgery. After raising the mucoperiosteal flap, the width of alveolar ridge was evaluated. Excellent ridge expansion of about 3 mm was obtained on both the sides (Figure 6). Implants were placed in the preplanned positions. On the left side, 4.3 × 13 mm implants (Uniti, Equinox) were placed in the 1st and 2nd molar region (Figure 7) and 3.7 × 8 mm implant was placed in the premolar region.

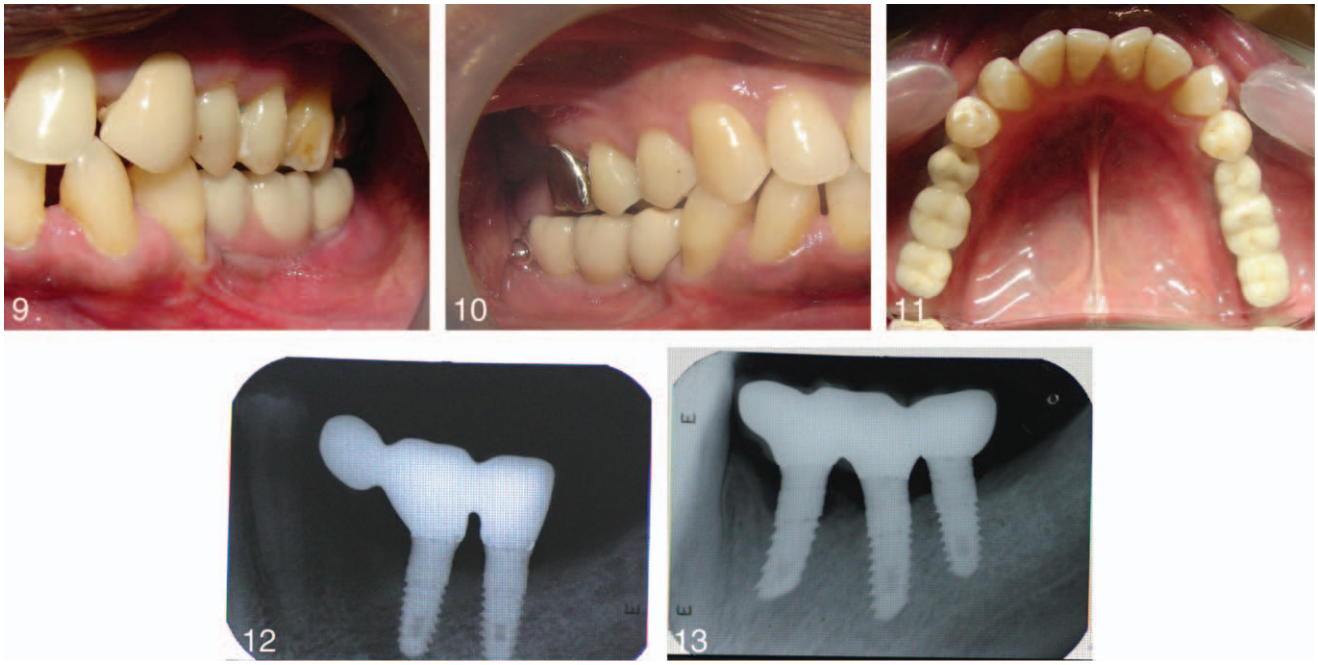
On the right side, implants (Uniti, Equinox) 4.3 × 13 mm were placed in 1st and 2nd molar position (Figure 8). An implant could not be placed in the premolar region as the mental foramen was close to the alveolar ridge. The mucoperiosteal flap was sutured back with 4-0 nonresorbable sutures. Routine postoperative instructions and medications were given.

Clinical monitoring of the patient was carried out after each stage. The implants were uncovered after 3 months and prosthetic rehabilitation was done (Figures 9 through 11). The patient was followed up for 1 year following prosthetic rehabilitation, and there are no reported complaints or complications. The radiographs taken 1 year postoperatively show the implants to be osseointegrated (Figures 12 and 13).

Discussion

Narrow alveolar ridges need to be augmented before implant placement for achieving a successful and predictable treatment outcome. Onlay bone grafts used for lateral augmentation require invasive surgical procedures to obtain the graft and implant placement and are delayed 3–6 months as required for the integration of the graft. The rate of lateral onlay bone graft resorption has been reported from 20–50% after 6 months.[12] For GBR procedures, the drawbacks include membrane collapse and membrane exposure leading to infection.[13,14]

Interpositional augmentation includes ridge split and ridge expansion procedures. These procedures have shown predictable outcomes in the maxilla[6,15]; however in the mandible, there is a greater risk of fracture of osteotomized segment due to the presence of thick cortical plates. Therefore, in this case, initially only vertical as well apical horizontal cuts were made without any attempt at expansion to minimize the risk of fracture. A staged approach allowed the formation of the immature bone callus at the corticotomy site, which was flexible enough to perform the ridge split procedure. In Stage 1, the lingual periosteum and, in Stage 3, the buccal periosteum were preserved to ensure adequate blood perfusion to the bone. Because this procedure was divided into two steps, the location of



Figures 9–13. **Figures 9–11.** Prosthetic rehabilitation. **Figures 12 and 13.** Intra-operative periapical radiograph showing well osseointegrated loaded implants.

greenstick fracture was predictable and predetermined. A substantial increase in width was obtained on both right and left sides with this technique. Thus, the drawbacks of the onlay bone graft and membrane were overcome with the use of staged ridge split approach.

In 2006, Enislidis et al[16] reported on the staged ridge splitting technique where implants were placed in Stage 2. However, in this case, the implant placement was delayed by 3 months, which allowed mature bone formation and ensured primary stability of implants.

Traditionally, osseous surgery has been performed by either manual or motor-driven instrumentation. Manual instruments are difficult to control in cortical bone, particularly where precise osteotomies are essential. Motor-driven instruments generate a significant amount of heat, and overheating of adjacent tissue may alter or delay the healing response. Motorized cutting tools also decrease tactile sensitivity. The piezoelectric surgical instrument offers three important advantages[17] for osseous surgery: First, the cut is precise because it is produced by microvibrations of the cutting tip. Second, the cut is safe because the ultrasonic frequency used does not cut soft tissue.[18] Third, the cutting action is less invasive, producing less collateral tissue damage, which results in better healing. The patient discomfort is also minimal.

The time required for the three stages would be similar to other augmentation procedures; however, a more predictable outcome with less patient morbidity was obtained with the staged ridge split approach.

Conclusion

The soft and hard tissue wound healing was uneventful. The implants were well osseointegrated after 3 months, and prosthetic rehabilitation lead to restoration of function. Thus, the staged ridge split approach is a safe and predictable approach as compared to single-stage ridge split, especially when combined with the use of piezosurgery. This technique is not technique sensitive and presents minimal risk of damage to adjacent hard and soft tissues. This technique can be successfully used for augmentation of compromised mandibular alveolar ridges.

Abbreviations

GBR: guided bone regeneration
USBS: ultrasonic bone surgery

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