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CASE REPORT

# Staged Ridge Split Procedure in the Management of Horizontal Ridge Deficiency Utilizing Piezosurgery

**A. B. Tarun Kumar[1] · M. G. Triveni[1] · V. Priyadharshini[1] · D. S. Mehta[1]**

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**Abstract**
*Aim and Objectives* Edentulism is an incapacitating and irretrievable condition which can lead unswervingly to functional limitation, physical, psychological and social handicap. Maintenance of bone after tooth loss to improve retention, function, and performance of the restoration is a challenging task. The existence of a thin edentulous ridge signifies a clinical situation that is more complex for the placement of endosseous implants. Dental rehabilitation of the edentulous ridges with oral implants has become a routine treatment modality in the last few decades with consistent long term results.
*Methods* A staged ridge spilt procedure was performed in the maxillary posterior edentulous region employing piezosurgery for the augmentation of horizontal ridge deficiency which was followed by the successful placement of implant supported prosthesis.
*Results* At the 20 months follow-up, stable results were appreciated with minimal bone loss around the implants.
*Conclusion* This proficient technique precludes the need for a second surgical site for the procurement of graft which in turn decreases patient discomfort. Hence this procedure can be used as an alternative to other strenuous procedures.

**Keywords** Dental implants · Horizontal ridge augmentation · Platelet rich fibrin · Ridge split · Piezosurgery

✉ V. Priyadharshini
privina05@gmail.com

[1] Department of Periodontics, Bapuji Dental College and Hospital, Davangere, Karnataka, India

## Introduction

One of the most common conditions encountered in implant dentistry is the presence of deficient bone quantity to allow for the appropriate implant placement according to standard protocols. The atrophic edentulous ridges present an inimitable challenge to the implant surgeon. It has come to light that for a completely functional and esthetic restoration, a comprehensive hard and soft tissue harmony has to be achieved before and after implant placement. The present perspective is to place an implant in a prosthetically driven position.

Various techniques for augmentation of the ridges have been addressed in the past which includes: onlay bone grafts harvested from the hip, maxillary tuberosity, symphysis of the chin, mandibular ramus and external oblique ridge. All these methods have their own shortcomings, the most important being the inevitability of a second surgical site for procuring the graft. Hence various alternative procedures were developed to minimize this morbidity. Splitting and expanding the edentulous ridge for bone augmentation and implant placement is considered as an innovative technique as it avoids the need for a second surgical site which further reduces the ailment of the patient.

This ridge split technique was developed by Simion et al. [1] and Scipioni et al. [2] in the early 1990s. Simion et al. [1] aimed at creating a "self-space making defect" by splitting the atrophic crests in two parts with a longitudinal greenstick fracture displacing the vestibular cortical bone both in maxilla or mandible to create a gap, which was used to contain the inserted implants. The maxillary bone owing to the thinner cortical plates and softer medullary bone compared to that of the mandible is a good candidate for performing a ridge spilt procedure. In this procedure, the corticotomies can be performed using various

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instruments like no 15 blade, beaver blade, razor-sharp chisel, round bur, fissure bur, diamond disk, reciprocal saw, piezoelectric device, or laser (erbium: yttrium–aluminum-garnet, erbium, chromium-doped: yttrium-scandium-gallium-garnet [3].

The introduction of the use of piezosurgery for ridge expansion which uses modulated functional working frequency of 25–30 kHz permits accurate tactile controlled osteotomies that can be performed adjacent to vital anatomical landmarks like the maxillary sinus or the mandibular canal [4]. The piezosurgical saw is safer and more precise than the conventional rotary bur or the reciprocal saw when performing osteotomies as the micro vibrations produced by them make selective bone cuts possible without soft tissue damage.

This case report throws light on the use of a consistent technique for horizontal ridge augmentation namely the piezosurgery assisted ridge splitting followed by successful implant placement with subsequent prosthetic rehabilitation in the maxillary posterior edentulous area.

## Case Presentation

A 45 year old healthy female patient came to the Department of Implantology with the chief complaint of missing left upper back teeth with inability to chew in the same area. Her medical history was non-contributory. Her past dental history revealed that she had got her teeth extracted due to caries 10 years back. She was also using a removable partial denture for the missing teeth for the past 5 years which was unsatisfactory.

Intra oral clinical examination revealed that the patient had missing maxillary left second premolar and molar (Fig. 1a). There was deficient ridge width and the orthopantomogram revealed that there was pneumatization of the maxillary sinus in relation to the molars. Computer tomography (C.T.) images revealed a horizontal ridge width of about 2.95 mm and vertical height of 13.47 mm in relation to premolar (Fig. 1b). The horizontal and vertical dimensions of the ridge in relation to molar were 2.20 and 4.42 mm respectively (Fig. 1c). The treatment plan was considered in 2 stages: Stage (1) Ridge splitting for horizontal ridge augmentation and Stage (2) Implant placement in relation to the premolar and molar with indirect crestal sinus elevation in relation to the molar. The surgical procedure was explained to the patient and an informed consent was obtained for the same.

Prior to the administration of local anesthesia, the patient rinsed with 15 ml of 0.2 % chlorhexidine digluconate to reduce the bacterial load. Loading dose of Augmentin 1.2 mg I.V. was given 1 h before the procedure and 10 ml of venous blood was obtained to prepare the platelet rich fibrin (PRF) using Choukroun's protocol [5]. The surgical site was anesthetized using 2 % xylocaine HCl with adrenaline (1:200,000). A mid-crestal incision was given in the region of the premolar and molar and a vertical releasing incision was placed anteriorly to reflect a full thickness mucoperiosteal flap. Periosteal releasing incisions were given in order to relieve the tension on the flaps while suturing. The pre-operative horizontal ridge width measured was around 2–3 mm. A longitudinal mid-crestal osteotomy was performed using the piezosurgical saw in a side to side cutting motion. The depth of the first cut was 8–10 mm in relation to the premolar and 3–4 mm in relation to the molar. Two vertical bone incisions were made, one at the mesial and other at the distal aspect at least 2–3 mm from adjacent root (Fig. 2a). The osteotomy site was expanded using expansion screws (M. I. S. Bone compression kit) until it was 7–8 mm wide (Fig. 2b). The site was grafted with irradiated allogenic cortical particulates (Rocky mountain allograft) (Fig. 3a). PRF membrane was prepared using PRF box and was placed over the grafted site (Fig. 3b). This was followed by the placement of collagen membrane (RCM, ACE) in order to prevent the epithelial down growth and as a means to provide space for bone regeneration (Fig. 3c). After achieving primary closure of the flaps the site was sutured with horizontal mattress and interrupted sutures using polyamide 5-0 suture material. Post-operative instructions were given and the analgesics (combination of paracetamol-500 mg and diclofenac-50 mg thrice daily for 3 days) and antibiotics (amoxicillin 500 mg thrice daily for 5 days) were prescribed. Healing was uneventful and within normal limits.

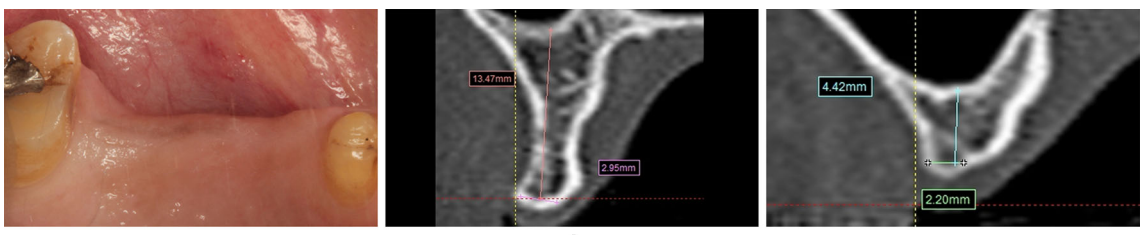


**Fig. 1** **a** Preoperative view of atrophic alveolar ridge in relation to 25 and 26. **b** Computer tomography image in relation to 25. **c** Computer tomography image in relation to 26

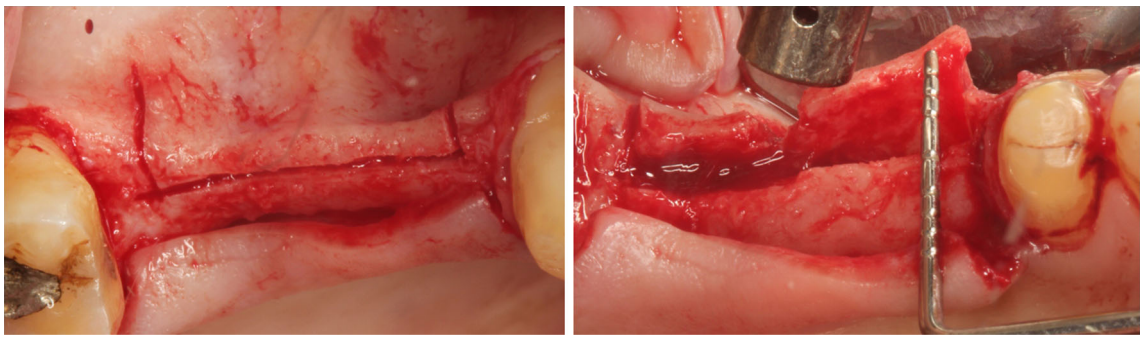


**Fig. 2** **a** Two vertical bone incisions on the distal and mesial aspect of 25 and 26 region. **b** Osteotomy site after expanding with M.I.S bone compression kit

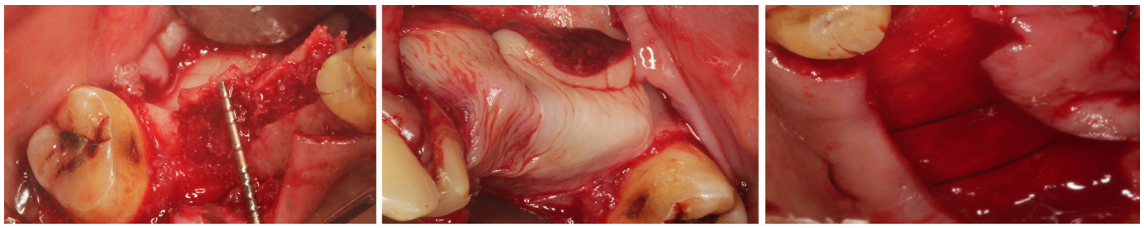


**Fig. 3** **a** Site grafted with irradiated allogenic cortical particulates. **b** PRF membrane placed over the grafted site. **c** Collagen membrane placed

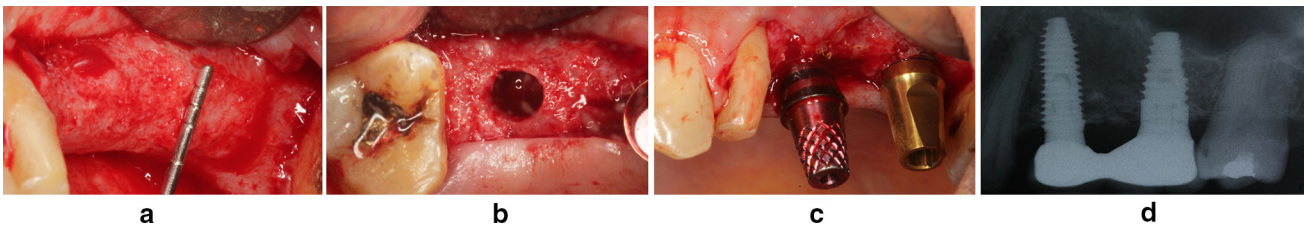


**Fig. 4** **a** Re-entry after 4 months revealing adequate horizontal bone width. **b** Piezoelectric internal sinus elevation procedure in relation to 26. **c** Placement of Neo-Biotec CMI IS II 4 × 13 in the premolar site and Bio-Horizon laser lok 4.6 × 10.5 in the molar site. **d** Intra Oral Periapical radiograph taken in relation to 25 and 26 after 20 months revealing no significant bone loss around the implants

The operated site was then re-entered after 4 months which revealed 6 mm of bone regeneration in the premolar area and 8 mm of bone in the molar area (Fig. 4a). With the help of a surgical stent, two osteotomy sites were prepared. Indirect sinus elevation was done in relation to 26 using PISE (Piezoelectric internal sinus elevation) technique [6] (Fig. 4b). The elevated sinus cavity was grafted with PRF, followed by implant placement. Two implants (Neo-Biotec CMI IS II platform switched 4 × 13 mm implant in the premolar site and Bio-Horizon laser lok 4.6 × 10.5 mm implant in the molar site) were placed in their prosthetically driven position (Fig. 4c). The area was then sutured with expanded polytetrafluoroethylene 5-0 (ePTFE) suture material and postoperative instructions were reinforced. Healing was satisfactory. The implants were allowed to osseointegrate for 4 months after which the site was exposed to place the healing caps to obtain the soft tissue contour around them. After 15 days the final impression was made followed by the placement of ceramic fused to metal fixed implant supported prosthesis which was checked for its precise fit. Patient was kept under regular follow-up with 3 months visit after placement of final prosthesis. The final radiograph taken after a period of 20 months showed no significant bone loss around the implants (Fig. 4d).

## Discussion

Bone loss is an ongoing process following tooth loss affecting the mandible four times more than the maxilla [7]. The loss of tooth structure causes impaired mastication,

functional and sensory deficiencies of the oral mucosa, musculature and salivary glands. Apart from this it also affects the general health and quality of life of the patient [8]. Hence accurate restoration of the lost tooth structure is of prime importance. The four main surgical approaches for the augmentation of atrophic ridges includes guided bone regeneration, bone grafting, expansion and distraction techniques and a combination of these methods [9].

Ridge split technique essentially reconstructs the alveolar bone by creating a green stick fracture which is a reliable and relatively non-invasive procedure. It principally consists of splitting the vestibular and buccal cortical tables while displacing the vestibular cortical bone [9]. Simion et al. [1] and Scipioni et al. [2] introduced this technique by aiming at creating a self-space making defect with the help of chisels which prevented the membrane from collapsing into the defect from which the osteogenic cells can be recruited [1]. The advantage of this ridge split technique is that the expansion created heals with rapid vascularization and bone remodeling in a manner similar to that occurring in fractures [10]. But the limitation of this technique is its inability to create bone vertically and the pre-requisite that there should be cancellous bone present between the buccal and lingual plates to allow separation.

Though the use of manual instruments offers good control when removing small amounts of bone, the efficiency of these instruments while performing precise osteotomy cuts is questionable. The motor driven instruments which are used for bulk removal of bone has the disadvantage of increasing the temperature which precludes for the necrosis of bone. The piezosurgical device, an innovative development for performing osteotomies works on the principle of ultrasonic vibrations. When compared with the traditional rotary instruments, piezosurgery requires less pressure application which enhances the precision for cutting. It also has the advantage that it cuts only hard tissue sparing the soft tissue which prevents any kind of accidental injury to the tissues. Unlike conventional burs and micro saws, piezosurgical inserts do not increase the tissue temperature, which again reduces the risk of postoperative necrosis [11]. In the present case the constructive upshot of piezosurgery was evident both while splitting the edentulous ridge as well as during indirect sinus elevation.

The grafting procedure done in the present case is an interpositional or "sandwich" grafting which is based on the theory that bone placed between 2 pieces of pedicled bone with internal cancellous bone will undergo rapid and complete healing and graft incorporation [10]. In the present case there was excellent bone formation after 4 months re-entry into the grafted site with no complications.

The PISE technique was introduced by Sohn et al. in 2009 which has the advantage of maintaining the integrity of the sinus membrane [6]. This technique results in efficiently obtaining tactile sense of the sinus membrane during osteotomy of the sinus floor, and also reduces the risk of perforation of the Schneiderian membrane. It is a minimally invasive and proficient technique for sinus lift as it does not produce benign positional paroxysmal vertigo which can occur as a complication secondary to the usage of sinus osteotomes and mallets [6]. In the present case the pneumatized sinus in relation to the molar was lifted with the help of a piezosurgical unit and the area was grafted with PRF which acts as a biological bandage that can seal off the micro tears produced during the surgery [5, 12].

PRF which is a strictly autologous fibrin matrix containing large quantity of platelet and cytokines is an optimal matrix for migration of endothelial cells and fibroblasts. It certificates rapid angiogenesis and improved remodeling of fibrin into a more resistant connective tissue. The effortlessly applied PRF membrane acts much like a fibrin bandage, serving as a matrix to hasten the healing of wound edges. It has been substantiated that the fibrin-rich blocks with concentrated growth factors as the sole material acted as an alternative to bone grafting and induced fast new bone formation in the sinus. It also provides noteworthy postoperative protection of the surgical site and seems to accelerate the integration and remodeling of the grafted biomaterial [12]. The effectiveness of PRF was unmistakable in this present case both during the first stage where it was used to protect the grafted site and during the second stage to augment the sinus cavity.

A staged approach was done in the present case for the reason that the patient had a long standing edentulism that caused the pneumatization of the maxillary sinus in relation to the molar which precluded the immediate placement of the implants. Moreover the buccal cortical plate was also thin and the chance of labial plate fracturing was avoided by using a staged approach. In the study by Anitua et al. [9] this approach presented stable results facilitating the placement of large diameter implants, that otherwise could not be positioned with the conventional one-stage technique. This staged ridge split procedure produced outstanding results after a time period of about 20 months with minimal bone loss around the implants which could also be attributed to the placement of a platform switched and laser-lok implants.

## Conclusion

To conclude, this renewed technique of ridge splitting followed by implant placement has reduced the morbidity of the patient by avoiding a second surgical site for augmentation of the atrophic ridge. The use of piezosurgery along with the PRF membrane placement has shown remarkable results in the present case. There was no

significant bone loss after a period of 20 months follow-up. The use of a staged approach has optimized the esthetic and functional demands of the patient. Thus, this technique can be used as a noble alternative to other arduous surgical procedures.

**Conflict of interest** None.

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