Decortication-assisted Guided Bone Regeneration in Anterior Ridge Defect: A Novel Approach to Horizontal Ridge Augmentation

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ABSTRACT

Chronic periodontitis is a prevalent inflammatory disease that often results in horizontal alveolar bone loss, posing significant challenges to periodontal health and esthetics in the anterior dentate region. Guided bone regeneration (GBR) has been established as a reliable therapeutic approach for reconstructing such defects. Recently, selective alveolar decortication has gained attention for its ability to stimulate the Regional Acceleratory Phenomenon (RAP), which enhances local bone turnover and accelerates regeneration. This case report describes the management of horizontal bone loss in a natural dentate anterior ridge using decortication-assisted GBR augmented by a uniquely designed dumbbell-shaped Guided Tissue Regeneration (GTR) membrane.

This case report highlights the surgical technique involved in selective cortical perforations to invoke RAP and promote vascularisation, combined with barrier membrane placement to achieve optimal space maintenance and tissue exclusion. The dumbbell-shaped membrane demonstrated superior adaptation to the complex morphology of the anterior ridge, improving stabilisation and regenerative outcomes. Clinical and radiographic follow-up up to 6 months confirmed significant horizontal bone gain, supporting the long-term preservation of alveolar bone volume and contour in the presence of natural teeth. This approach addresses the multifactorial challenges of managing horizontal ridge defects in dentate patients, emphasising the biological rationale for combining decortication with GBR techniques. It indicates the importance of tailored membrane design in enhancing regenerative predictability. The case report also highlights the potential of this advanced protocol to restore functional and esthetic architecture in periodontally compromised anterior sites, promoting comprehensive periodontal regeneration beyond traditional implant site development.

Keywords: *Chronic periodontitis, horizontal bone loss, Guided Bone regeneration, regional acceleratory phenomenon, selective alveolar decortication*

Key Points

- A combination of regional acceleratory phenomenon (RAP) with GBR, which resulted in enhanced vascularity, osteogenic cell migration, and graft integration.
- A biologically driven GBR modification where intra-marrow penetrations enhance angiogenesis, osteogenesis, and graft stability while reducing healing time.
- A minimally invasive, reproducible, and cost-effective approach that can be applied in routine practice by trained dental professionals

Introduction

Chronic periodontitis is a prevalent inflammatory disease that leads to progressive destruction of the supporting structures of the teeth, including the alveolar bone. Horizontal alveolar bone loss is one of the most common patterns of bone loss, characterised by a generalised reduction in ridge width and support for existing teeth, and poses a prevalent and challenging clinical scenario in dentistry. Unlike vertical defects, treatment options for horizontal bone loss have historically been limited due to its anatomy, which makes housing of the regenerative material difficult. It has been estimated that over 92% of affected teeth show a horizontal bone loss pattern. Conventional therapy aims at open flap debridement, failing to halt ongoing resorption and loss of buccal bone.[1,2]

Advances in regenerative therapy have brought guided bone regeneration (GBR) to the forefront for managing such defects. Contemporary GBR methods employ the PASS principle that includes placement of the barrier membranes and bone grafts as scaffolds to encourage selective cellular repopulation, promoting both angiogenesis and bone formation while preventing soft tissue collapse. However, horizontal bone defects in tooth-bearing regions present added complexity due to the necessity of preserving adjacent teeth and the delicate periodontal structures.[3]

Selective alveolar decortications (SAD) marked by precise perforations in the cortical plate have recently been incorporated into GBR procedures, acting to stimulate local vascularity and recruit progenitor cells directly to the graft site. Selective alveolar decortication fundamentally alters the local blood supply and cellular environment by creating targeted perforations in the cortical bone, which stimulates hyperaemia at the surgical site. This regional increase in vascularity provides direct access for progenitor cells, growth factors, and nutrients from the medullary bone to migrate into the cortical plates, dramatically accelerating bone remodelling and healing responses.[4]

Studies demonstrate that decortication induces a "regional acceleratory phenomenon" (RAP), characterised by a rapid upsurge in osteoclast formation followed by bone remodelling, due to both pre-existing osteoclast precursor activation and new differentiation from circulating

mononuclear cells entering through dilated capillary beds. This process not only lowers local bone density, making it more receptive to graft integration, but also expedites recruitment of pluripotent cells and growth factors essential for robust bone regeneration.[5,6]

This synergy enhances the biological milieu, paving the way for predictable horizontal ridge augmentation. Through a combination of these refined surgical techniques and advanced biomaterials, clinicians can now effectively restore ridge width and stability in partially dentate anterior regions, improving both esthetic and functional outcomes for patients.[7] Therefore, the present case report focuses on the augmentation of horizontal bone loss in the anterior dentate ridge using decortication-assisted guided bone regeneration (GBR). This technique combines the surgical perforation of cortical bone (decortication) to enhance vascularisation and cellular infiltration with the use of barrier membranes and graft materials to promote new bone formation.

CASE PRESENTATION

Case History

A 65-year-old male patient reported to the department with a chief complaint of dirty teeth and foul smell for 2 months in the entire tooth region. Clinical examination revealed generalized pale pink firm and resilient gingiva in the upper front teeth region (aesthetic zone) and a lobulated appearance of attached gingiva in relation to # 34- #42. The tension test was positive, indicating an aberrant frenal attachment that was papillary in nature, contributing to a midline diastema along with gingival recession in relation to teeth #11-#22. A pocket probing depth (PPD) of 6 mm was also observed interdentally in the same region, indicative of bone loss. However, #21 was found to be congenitally missing, and a midline shift was evident. Therefore, the condition was explained to the patient, and surgical intervention, including frenectomy followed by GBR along with selective alveolar decortication, was planned after obtaining informed consent from the patient. (Figures 1 &2)

Figure 1: Pre-operative clinical picture showing papillary frenal attachment i.r.t #11-#22

Figure 2: Pre-operative clinical picture showing a PPD of 6mm i.r.t #11-#22 (PPD- Probing Pocket Depth)

Radiological Findings

Presence of PPD ≥ 6mm was indicative of bone loss. Therefore, an orthopantomogram (OPG) was taken that showed a generalized horizontal bone loss in the entire teeth region with increased loss of interdental bone height i.r.t #11- #22. (Figure 3) To confirm these findings, radiovisiography (RVG) of the same region was performed to obtain a magnified image. RVG revealed similar findings of horizontal interdental bone loss. (Figure 4)

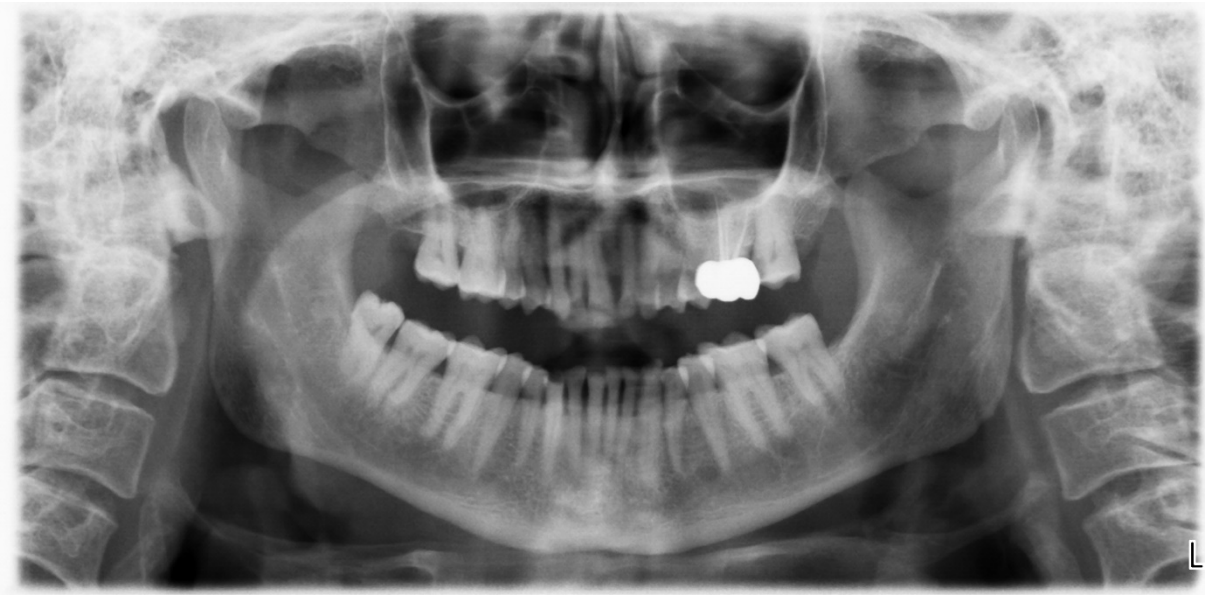

Figure 3: Orthopantomogram (OPG) showing generalized horizontal bone loss

Figure 4: RVG (Radiovideograph) taken at baseline to confirm the finding of OPG i.r.t #11- #22

Clinical Procedure

Preoperative hematological investigations, including Bleeding Time (BT), Clotting Time (CT), Hemoglobin (Hb% %), and Random Blood Sugar (RBS), and vitals were assessed. All the parameters were within normal limits. Before administration of local anaesthesia containing adrenaline (1: 80,000), a patch test was performed. On obtaining negative results, frenectomy was done using a scalpel to release the tension 4 weeks before GBR. After uneventful and complete healing, GBR was attempted.

Cervical incision using # 15 blade was given, followed by interdental incision with #12 blade extending from #14- #24. A full-thickness (Mucoperiosteal) flap was reflected, exposing the horizontal bone defect. After complete debridement of the surgical site, selective alveolar bone decortication/ intra-marrow penetration was done by drilling holes utilising a round diamond. (Figures 5&6).

Figure 5: Mucoperiosteal flap elevation extending from #14- #24

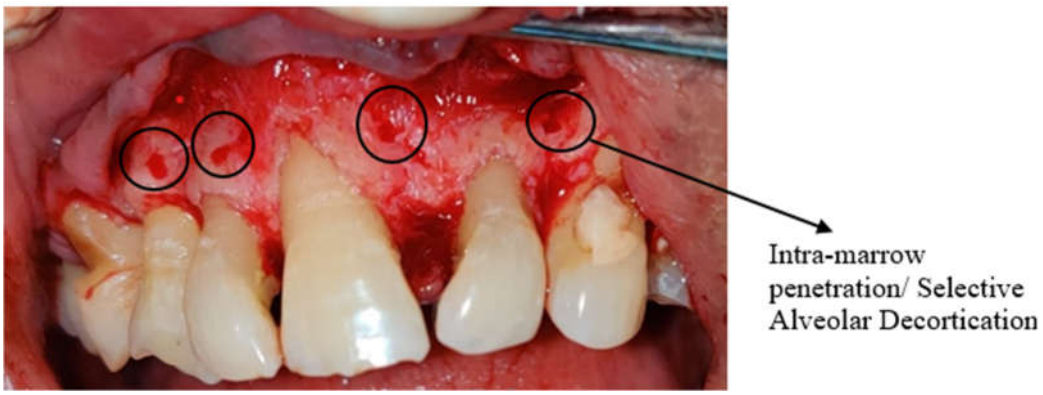

Figure 6: Selective Alveolar Decortication

Guided Bone Regeneration Procedure (GBR)

GBR was planned i.r.t. #11- #21 utilizing a combination of Xenograft (Geistlich Bio-Oss® Spongious bone substitute, granule size 0.25-1mm/1cc) and collagen membrane (Advanced Biotech Healiguide®, Bio-Resorbable Material Type-I Collagen, 15x30mm). According to the anatomy of the defect, a dumbbell-shaped sterile foil template was designed and placed interdentally i.r.t. #11- #21 to confirm the coverage of the defect. Once satisfactory coverage was achieved, the foil template served as a guide to shape the collagen membrane. (Figure 7) Pre-suturing of the GBR site was done using 3-0 non-resorbable silk sutures, while the collagen membrane was stabilized using 5-0 Vicryl resorbable sling suture. After the placement of the xenograft, first the resorbable sutures were tied to stabilize both the collagen membrane and the graft, followed by approximation of the flap with the non-resorbable ones. (Figures 8,9, and 10).

Figure 7: Dumbbell-shaped GTR membrane prepared for placement in the interdental area

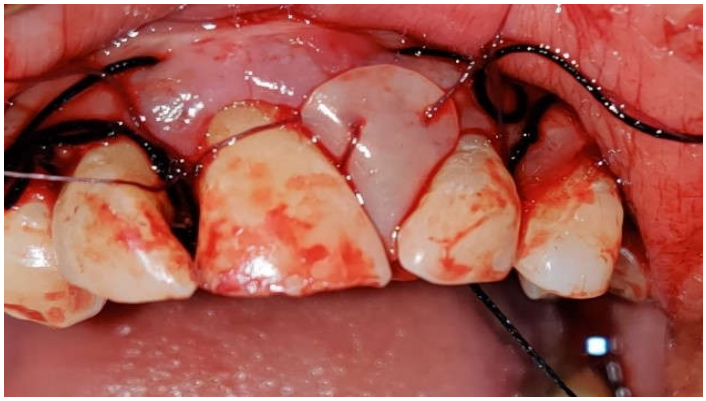

Figure 8: Placement of pre-sutured GTR Membrane

Figure 9: Placement of Xenograft (Bio-oss) before GTR membrane stabilization

Figure 10: Approximation of the mucoperiosteal flap covering the GTR membrane

Follow-up

The recall visits were scheduled at one week, 3 months, and 6 months. At every visit, radiographs were taken to assess the bone fill. Comparative evaluation from baseline to 6

months was done radiographically. The comparison revealed an increase in bone height of 3.13 mm and 2.97mm at 3 months and 6 months, respectively. Therefore, the results obtained were satisfactory and indicated a successful regeneration of the bone. (Figure 11)

Figure 11: Comparative evaluation of Radiographs at (a) Baseline, (b) 3 months, (c) 6 months

DISCUSSION

Horizontal bone augmentation in dentulous anterior maxillary areas represents an advanced, biologically demanding intervention, unlike augmentation performed solely for implant site preparation. The presence of natural teeth adjacent to the defect profoundly impacts the surgical approach, healing dynamics, and the end goal of restoring both the integrity and the contour of the alveolar ridge to support periodontal health and smile esthetics.[8,9]

Recent literature suggests that horizontal augmentation techniques, including decortication-assisted guided bone regeneration, symphyseal shell grafting, and innovative tooth-shell techniques, can routinely produce gains of 3–4 mm or more in ridge width even in the presence of natural teeth.[8] The use of autogenous bone or tooth shells influences the vitality of circumjacent tissues and the robust vascular network of dentulous areas, enhancing osteogenesis while minimising graft resorption, just as recent clinical trials demonstrate excellent stability and integration for up to six months post-grafting. Moreover, computer-guided harvesting and precise fixation of these grafts further contribute to procedural accuracy and postoperative outcomes, allowing clinicians to restore harmonious anatomical contours that mirror native ridge curvature [8,9,10]

A critical aspect in the dentulous anterior zone is the interplay between augmentation materials and the local soft tissue environment. Studies indicate that the dimensional stability and esthetic integration of the augmented bone are optimised when soft tissue is adequately managed, often requiring adjunctive connective tissue grafting or staged approaches for larger defects. Clear morphologic predictors for successful regeneration have emerged in ridges with greater concavity depth and more acute angles, which are associated with superior horizontal bone gain and minimal resorption, while the pre-existing periodontal health of adjacent teeth is vital to long-term success.[10,11]

Innovations have also widened the spectrum for choice of biomaterials, with tooth-shell grafts demonstrating less graft resorption and greater long-term dimensional stability compared to traditional autogenous bone grafts in clinical trials on lateral ridge augmentation within dentulous maxillae. The decreased incidence of perioperative complications remains low, and neurosensory disturbances have been reported across these modalities, particularly when intraoral donor sites are utilised.[8,9]

In summary, horizontal bone augmentation in the dentulous anterior maxillary region now offers a predictable, accurate, and esthetically oriented solution for reconstructing alveolar ridge defects due to chronic periodontitis. This combination of novel approaches enables clinicians to rehabilitate the periodontal architecture and soft tissue profile not just for implant placement, but to optimise oral function and smile esthetics in the presence of natural teeth [8-11].

CONCLUSION

In conclusion, the incorporation of a dumbbell-shaped GTR membrane represents a pivotal advancement, as this configuration was designed to perfectly adapt to horizontal bone defects in dentulous areas, maximising stabilisation by extending subperiosteally on both the buccal and lingual aspects of the ridge. It resulted in superior space maintenance and tailored exclusion of unwanted soft tissue ingress, which together created a biologically privileged environment for predictable bone regeneration. Beyond physical stability, the dumbbell shape enhanced membrane adaptation and tension-free closure, addressing the challenge of maintaining a secure, immobile barrier over augmented sites, especially adjacent to natural teeth, where contours are more complex. This anatomical compatibility markedly embellished regenerative outcomes by not only improving bone fill and dimensional gain, but also supporting the preservation of the native architecture for future periodontal health and esthetic integrity.

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The corresponding author and the first author planned the treatment strategy and conducted the surgery, along with drafting the manuscript. The remaining contributing authors helped in the final drafting and reviewing of the manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest.

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