

Decision Tree for Vertical Ridge Augmentation



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Vertical ridge augmentation (VRA) procedures before or during dental implant placement are technically challenging and often encounter procedure-related complications. To minimize complications and promote success, a literature search was conducted to validate procedures used for VRA. A decision tree based on the amount of additional ridge height needed (< 4, 4 to 6, or > 6 mm) was then developed to improve the procedure-selection process. At each junction, the clinician is urged to consider anatomical, clinical, and patient-related factors influencing treatment outcomes. This decision tree guides selection of the most appropriate treatment modality and sequence for safe, predictable management of the vertically deficient ridge in implant therapy. *Int J Periodontics Restorative Dent* 2018;38:269–275. doi: 10.11607/prd.3280

After extraction, the alveolar ridge undergoes significant resorption. The estimated 40% loss of ridge height presents a significant challenge to implant placement.^{1,2} Over the long term, the prevalence of peri-implantitis is high, affecting up to half of all implants.³ Both implant position and history of regeneration increase peri-implantitis risk, so careful treatment planning is key.⁴ Options include rebuilding height using vertical ridge augmentation (VRA) or placing a short implant. This article introduces a guide for successfully managing the vertically deficient ridge.

Vertical Ridge Augmentation Techniques

Strategies in this guideline for VRA include distraction osteogenesis (DO), onlay grafting (OG), and guided bone regeneration (GBR).

Distraction Osteogenesis

DO consists of surgical delineation of a bone segment followed by slow separation from basal bone, allowing new bone fill.⁵ DO is limited to vertical augmentation.⁶ Due to the complexity of DO, the authors do not recommend this procedure except for severe vertical deficiencies.

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Onlay Grafting

An onlay graft is a bone block. Complications include incision dehiscence, graft exposure, graft loss, and sensory changes.^{7,8} Due to these complications, short implants should be considered as an alternative.⁹ The greatest surgical challenge in OG is maintenance of soft tissue closure.⁶ Allogeneic and xenogenic block grafts are an alternative to autogenous blocks, but evidence is limited.^{10,11}

Guided Bone Regeneration

GBR has advantages over OG due to avoidance of a second surgical site and reduced complications. GBR uses barrier membranes for space maintenance and exclusion of non-bone-forming cells.¹² GBR can be applied at the time of implant placement or staged 4 to 9 months prior.¹ Adherence to the principles of primary closure, angiogenesis, stability, and space maintenance (PASS) maximizes GBR success.¹² Absorbable and nonresorbable barrier membranes are available. Collagen (CM) is a common absorbable membrane. Nonresorbable barriers include titanium (Ti) mesh (Ti-mesh), expanded and density polytetrafluoroethylene (PTFE), and Ti-reinforced PTFE (PTFE-TR). The most common complication for GBR is membrane exposure, which compromises the amount of regeneration.⁸

Survival is high for implants placed after vertical GBR (93.75% to 100%), and stability has been maintained over 4 to 5 years.^{6,8,13,14} The limited data on VRA, heterogeneity,

and small sample sizes hinders decision making.^{6,14-16} More data exists on nonresorbable versus resorbable membranes, but both types are comparable.¹⁵ A nonresorbable, Ti-reinforced membrane (PTFE-TR) may improve space maintenance and eliminate the need for tenting screws used with absorbable membranes.¹⁷⁻²¹ Extrapolating from the literature, GBR is a preferred technique because it allows for simultaneous horizontal augmentation (not possible with DO), and has fewer complications than OG.^{15,16} GBR with PTFE-TR can yield close to 100% success for VRA in all three (small, medium, and large) elevation height groups.^{17,18,20-22}

Short Implants

A short implant (< 8 mm) may be preferred over VRA due to their lower rates of complications and implant failures.^{16,23,24} Short implants show similar marginal bone levels and survival rates to ≥ 10 mm implants, but the peak failure rate occurred at an earlier point (4 to 6 versus 6 to 8 years).²⁵ Short implants decrease treatment time (by an average of 4 months), and patients prefer them 100% over grafting.^{26,27} This guide defines a short implant as < 8 mm. Short implants are an option for all stages of vertical deficiency if the remaining bone is sufficient.

Systemic and Local Factors

Prior to surgery, it is critical to ensure good oral and systemic health of the patient. A more conservative surc-

cal approach such as short or tilted implants should be considered for medically compromised patients. A thorough clinical and radiographic examination should be performed to evaluate the local anatomical factors.

Important soft tissue-related factors include keratinized mucosa (KM) width and vestibular depth. If soft tissue is deficient, its augmentation should be performed after VRA to prevent scar tissue development, which can limit flap extension and passive primary closure.²¹ Soft tissue augmentation after VRA helps reestablish lost vestibular depth.²¹ A combination approach of an apically placed free gingival graft with coronally positioned free connective tissue graft can increase KM width while maximizing esthetics.²¹

The Decision Tree

This decision tree (Fig 1) is based on the amount of apicocoronal elevation needed for standard-length implant placement (≥ 8 mm). Strategies for small (< 4 mm), medium (4 to 6 mm), and large (> 6 mm) vertical ridge augmentation are proposed.

Small Apicocoronal Elevation (< 4 mm)

GBR may be used to predictably treat small vertical defects. Simultaneous implant placement and GBR can be considered for 3-mm mean vertical gain.⁸ Both resorbable and nonresorbable membranes may be used. CM performed similarly to PTFE membranes at buccal implant

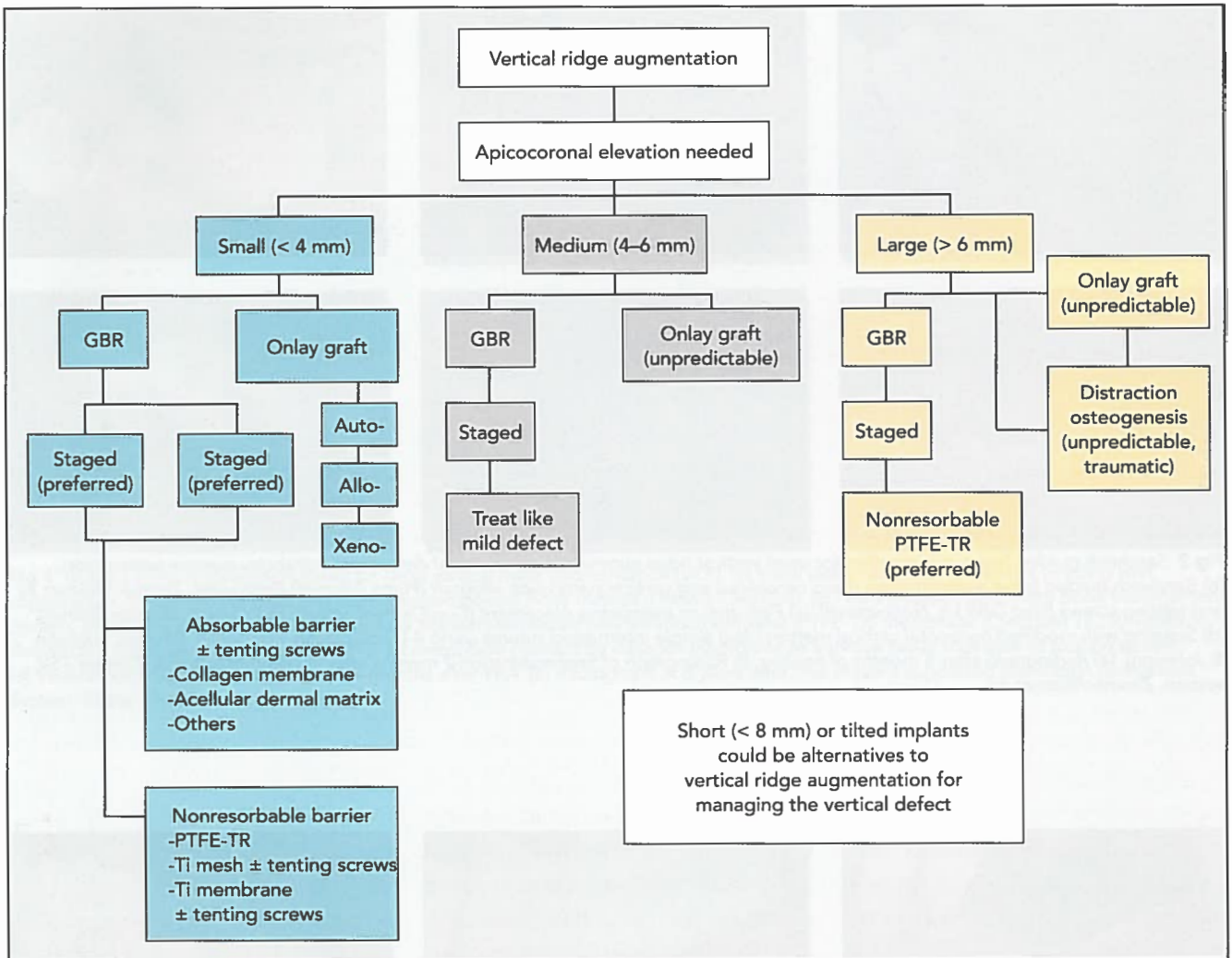


Fig 1 Decision tree for vertical ridge augmentation (VRA). The decision tree suggests procedures for managing the vertically deficient ridge based on amount of apicocoronal elevation needed for standard (≥ 8 mm) length implant placement. Strategies for small (< 4 mm), medium (4 to 6 mm), and large (> 6 mm) degrees of VRA are proposed. GBR = guided bone regeneration; PTFE-TR = titanium-reinforced polytetrafluoroethylene; Ti = titanium.)

dehiscence defects.^{28,29} A combination of autogenous and DBBM bone may be ideal for long-term graft stability due to autogenous graft shrinkage.^{30,31} When absorbable membranes are used, periosteal vertical mattress suturing with absorbable sutures are an alternative to tenting screws.²¹ Nonresorbable membranes have also shown success for VRA.^{17,18,20,21} Stable mem-

brane devices, such as PTFE-TR or Ti-mesh, provide enhanced stability and space. Figure 2 shows a small defect treated with GBR using a CM, tenting screws, and sandwich bone augmentation using a combination of autogenous and allogenic grafting (enCore, Osteogenics Biomedical).

OG may be considered for an average 4.75-mm vertical height

gain; however, complication rates are higher than with GBR.^{8,32} While autogenous grafts are considered the gold standard, allogeneic blocks show high success rates in case series.¹⁰ This strategy is recommended for mild maxillary VRA to avoid a mandibular harvest site.¹¹ Xenogeneic grafts show promising early reports, but more evidence is needed to validate the findings.³³

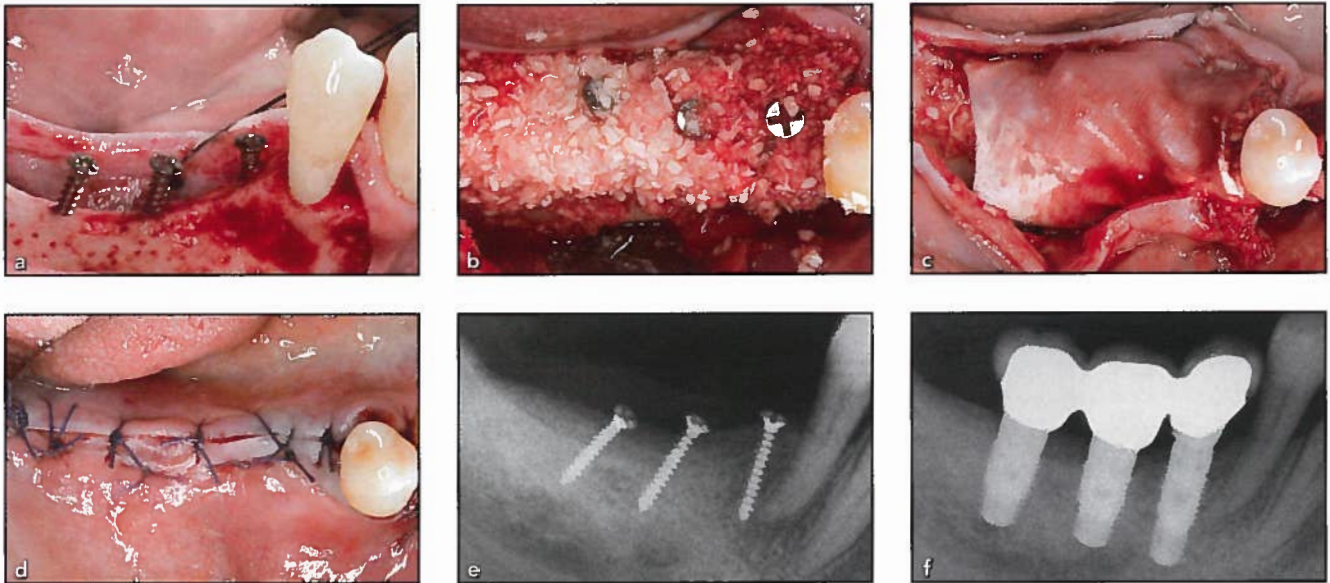


Fig 2 Sandwich guided bone regeneration for small vertical ridge augmentation. (a) Initial defect with intrabony marrow penetration. (b) Sandwich guided bone augmentation using cancellous and cortical particulate allograft (Puros Allograft Particulate, Zimmer/Biomet 3i) and tenting screws (Neo GBR kit, Neobiotech). (c) Pericardium membrane placement (CopiOs Pericardium Membrane, Zimmer Biomet). (d) Suturing with modified horizontal vertical mattress and simple interrupted sutures using 4-0 polyglactin 910 (Vicryl, Ethicon, Johnson & Johnson). (e) Radiograph after 5 months of healing. (f) Radiograph of final restoration 2 months after implant restoration (Zimmer TSV system, Zimmer/Biomet 3i).

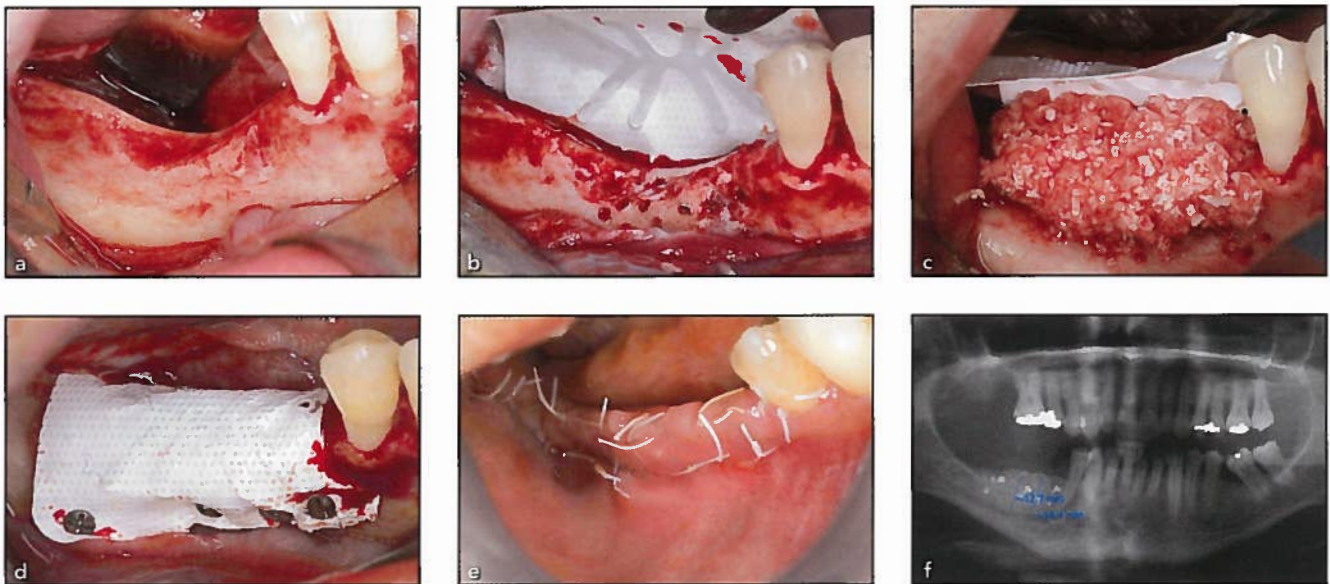


Fig 3 Guided bone regeneration using nonresorbable fixed membrane for medium vertical ridge augmentation (VRA). (a) Initial defect. (b) Intrabony marrow penetration and placement of titanium-reinforced polytetrafluoroethylene (PTFE-TR) membrane (Cytoplast Tr 250 Titanium-Reinforced, Osteogenics Biomedical) on the lingual aspect, secured with fixation screws (Profix, Osteogenics Biomedical). (c) Suturing with combination of autogenous bone and deproteinized bovine bone mineral (DBBM) (Geistlich). (d) Fixation of PTFE TR membrane on buccal aspect (Profix Osteogenics Biomedical). (e) Suturing with horizontal mattress and simple interrupted 3-0 and 4-0 PTFE sutures (Osteogenics Biomedical). (f) Radiographic bone gain at 9 months. Approximately 5 mm VRA was achieved.

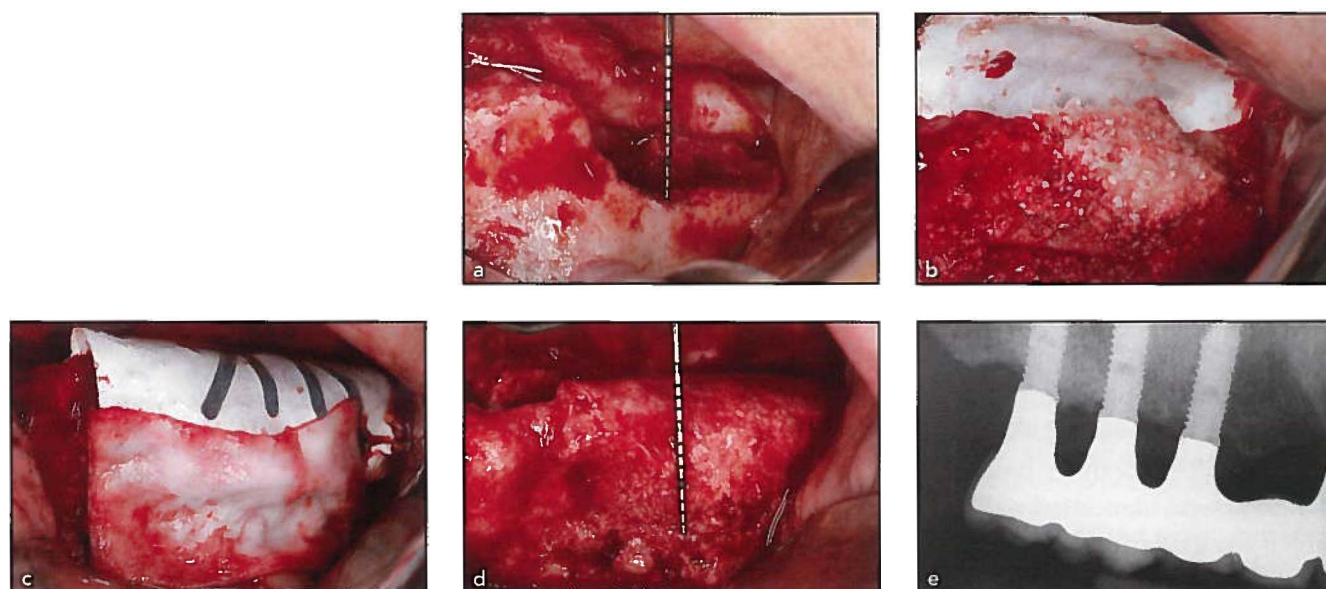


Fig 4 Guided bone regeneration (GBR) for large vertical ridge augmentation (VRA). (a) Initial defect exceeds 10 mm. (b) Grafting with combination of autogenous graft and deproteinized bovine bone mineral (DBBM) (Geistlich). (c) Fixed (Master-Pin-Control Bone Management System, Meisinger) nonresorbable high density titanium-reinforced polytetrafluoroethylene (PTFE-TR) membrane (Cytoplast Ti-250 Titanium-Reinforced, Osteogenics Biomedical) overlaid by collagen membrane to improve tissue tolerance of fixation screws. (d) Vertical ridge height gain > 10 mm 24 months after VRA. (e) Radiograph at 8 years after final implant-supported restoration (Brånemark System, Nobel Biocare).

Medium Apicocoronal Elevation

GBR may be used predictably for medium defects (4 to 6 mm) with adherence to the PASS principles.¹² Implant placement should be staged after 6 to 9 months to allow graft maturation.¹⁹⁻²² Nonresorbable stable membrane devices are preferred. The combination of PTFE-TR, DBBM, and particulate autogenous graft was used for a mean vertical gain of 5.45 mm with no complications.¹⁸

Cases with a thin gingival biotype may consider use of an absorbable CM alone or layered over a nonresorbable barrier to improve tissue tolerance. Since CM are non-rigid, tenting screws may enhance space maintenance. However, screws can create pressure spots, leading to

flap or screw exposure, so it may be preferable to use PTFE-TR (Fig 3). For absorbable and nonresorbable barriers, rigid fixation maximizes stability. While VRA requires significant flap advancement to obtain passive closure, free soft tissue grafting after VRA may be used to reestablish vestibular depth and KM width.²¹

Autogenous OG is another option for medium VRA. Overall, OG has a high complication rate, second to DO (8.1%), although the average implant survival rate is high (96.32%).⁸ Clinician skill is key when considering this technique.

Large Apicocoronal Elevation

VRA in large (> 6 mm) cases may require extensive soft and hard tissue

augmentation procedures over 1 to 2 years, so short implants should be considered.²¹

GBR using a nonresorbable membrane with a Ti-reinforced framework (Fig 4) may be the preferred choice for large VRA.^{17,18,20-22} A challenging area for primary closure is the maxillary anterior. A classification based on amount of VRA, presence of horizontal ridge deficiency, history of regeneration performed, periosteum status (native versus scarred), and vestibular depth guides flap management to maximize success of GBR.²⁰

DO is another option for severe defects, with the largest height gain (mean 7.08 mm) but the highest complication rate (22.4%).^{9,13} Complications include fracture,

mechanical problems, hypoesthesia, and implant failure.⁸ Despite these challenges, the implant survival rate is high and there may be less resorption than OG. This procedure should be reserved for the most severe cases.

Finally, OG may be considered for large VRA.³⁴ Due to donor site morbidity, short implants should be considered.³⁵ Long-term implant survival after OG was 93.4% over a mean of 39.9 months.³⁶ Based on the drawbacks associated with OG, GBR is a preferred choice in managing this specific clinical situation.

Conclusions

Limited evidence is present regarding vertical ridge augmentation.

When considering vertical ridge augmentation, the authors urge the clinician to evaluate pertinent anatomical (KM width, tissue thickness, anatomical structures), clinical (surgeon skill and experience), and patient-related (local and systemic health, preferences) factors. GBR is generally preferred due to its high predictability and low incidence of complications. OG should be reserved for patients resistant to allogeneic and xenogenic graft sources. Due to its high complication rate, DO should only be used in cases of extreme vertical ridge deficiency and with high operator experience and skill.

This guideline offers an approach based on available evidence and the authors' clinical experience to achieve safe, predictable management of vertically deficient ridg-

es. This approach is case-specific: in addition to anatomical factors, clinicians must consider their own experience and skill level and patient preferences and health concerns. This guideline allows judicious selection of vertical augmentation techniques for successful outcomes.

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