

Ridge Augmentation Vol. 3

Vertical Augmentation – Guided Bone regeneration

1. **TN** Simion M, Fontana F, Rasperini G, Maiorana C. Vertical ridge augmentation by expanded-polytetrafluoroethylene membrane and a combination of intraoral autogenous bone graft and deproteinized anorganic bovine bone (Bio Oss). *Clin Oral Implants Res* 2007; 18:620–629.
2. **ES** Urban IA, Monje A, Nevins M, Nevins ML, Lozada JL, Wang HL. Surgical management of significant maxillary anterior vertical ridge defects. *Int J Periodontics Restorative Dent* 2016;36:329–337
3. **BT** Urban IA, Monje A, Lozada J, Wang HL. Principles for Vertical Ridge Augmentation in the Atrophic Posterior Mandible: A Technical Review. *Int J Periodontics Restorative Dent*. 2017 Sep/Oct;37(5):639-645. doi: 10.11607/prd.3200.
4. **AK** Cucchi A, Bettini S, Ghensi P, Fiorino A, Corinaldesi G. Vertical ridge augmentation with Ti-reinforced dense polytetrafluoroethylene (d-PTFE) membranes or Ti-meshes and collagen membranes: 3-year results of a randomized clinical trial. *Clin Implant Dent Relat Res*. 2023 Jan 16.
5. **TV** Gallo P, Díaz-Báez D. Management Of 80 Complications In Vertical And Horizontal Ridge Augmentation With Non resorbable Membrane (d-PTFE): A Cross-Sectional Study. *Int J Oral Maxillofac Implants*. 2019 July/August;34(4):927–935. doi: 10.11607/jomi.7214
6. **DL** Urban IA. Techniques on vertical ridge augmentation: Indications and effectiveness. *Periodontol* 2000. 2023 Jan 31. doi: 10.1111/prd.12471.
7. **CM** Misch CM, Polido WD A "Graft Less" Approach for Dental Implant Placement in Posterior Edentulous Sites. *Int J Periodontics Restorative Dent*. 2019 Nov/Dec;39(6):771-779. doi: 10.11607/prd.4414.
8. **VX** Urban I, Montero E, Sanz-Sánchez I, Palombo D, Monje A, Tommasato G, Chiapasco M. Minimal invasiveness in vertical ridge augmentation. *Periodontol* 2000. 2023 Jan 26.
9. **TN** Misch CM, Basma H, Misch-Haring MA, Wang HL. An Updated Decision Tree for Vertical Bone Augmentation. *Int J Periodontics Restorative Dent*. 2021 Jan-Feb;41(1):11-21. doi: 10.11607/prd.4996.

Augmentation - Titanium Mesh

10. **ES** Pieri F, Corinaldesi G, Fini M, Aldini NN, Giardino R, Marchetti C. Alveolar ridge augmentation with titanium mesh and a combination of autogenous bone and anorganic bovine bone: A 2-year prospective study. *J Periodontol* 2008; 79:2039–2103.
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13. **TV** Al-Ardah A. et al. Managing titanium mesh exposure with the partial removal of the exposed site: A case series study. *J Oral Implantol* 2017
14. **DL** Cucchi A et al. Evaluation of complication rates and vertical bone gain after guided bone regeneration with non-resorbable membranes versus titanium meshes and resorbable membranes. A randomized clinical trial. *Clin Implant Dent Relat Res*. 2017 Oct;19(5): 821-32.
15. **CM** Chiapasco M, Casentini P, Tommasato G, Dellavia C, Del Fabbro M. Customized CAD/CAM titanium meshes for the guided bone regeneration of severe alveolar ridge defects: Preliminary results of a retrospective clinical study in humans. *Clin Oral Implants Res*. 2021 Apr;32(4):498-510.
16. **VX** Cucchi A, Vignudelli E, Franceschi D, Randellini E, Lizio G, Fiorino A, Corinaldesi G. Vertical and horizontal ridge augmentation using customized CAD/CAM titanium mesh with versus without resorbable membranes. A randomized clinical trial *Clin Oral Implants Res*. 2021 Dec;32(12):1411-1424.

Vertical Augmentation – Guided Bone regeneration

Topic: Vertical augmentation – guided bone regeneration

Authors: Simion M, Fontana F, Rasperini G, Maiorana C

Title: Vertical ridge augmentation by expanded-polytetrafluoroethylene membrane and a combination of intraoral autogenous bone graft and deproteinized anorganic bovine bone (Bio Oss).

Source: Clin Oral Implants Res 2007; 18:620–629

DOI: 10.1111/j.1600-0501.2007.01389.x.

Type: Prospective Case Series

Reviewer: Trisha Nguyen-Luu

Keywords: Autogenous bone, barrier membranes, deproteinized bovine bone, guided bone regeneration, osseointegration, vertical ridge augmentation

Background:

- Tiniti 1996: supracrestal bone regeneration up to 7 mm with e-PTFE + autogenous bone powder
- Rational of mixing autogenous bone with DBBM is to combine the scaffold properties of xenograft to the osteogenic + osteoinductive properties of autogenous graft
 - o Also reduce the amount of autogenous bone harvested + decreasing invasiveness + post-op morbidity

Purpose: To determine the efficacy of a vertical ridge augmentation using 1:1 mixture of deproteinized bovine bone mineral and autogenous bone graft with an expanded-polytetrafluoroethylene (e-PTFE) membrane)

Material and methods:

- 7 patients requiring 10 vertical ridge augmentations in the mandible was included in the study
- e-PFT Gore-tex and a composite graft of 1:1 mixture of DBBM (Bio-oss) + autogenous bone harvested from restromolar region using trephine burs was used
- 27 Branemark implants (Nobel Biocare) were placed
 - o Simultaneous implant placement + GBR: implants were left 2-7 mm protruded from bone crest + decortications completed + bone grafted + e-PTFE membrane was adapted + fixed to the crestal bone protecting the graft
 - o Staged surgery GBR + implants 6-9 months after: tenting screws left to protrude 0-5 mm from bone crest
- 2 patients with bilateral partial edentulism underwent a split mouth design where 1 side had the composite graft and the other side only had the autogenous graft.
- Intraoral surgical measurement at 1st surgery + membrane removal to evaluate vertical bone gain
- 11 biopsies from the regenerated area were taken and underwent histological + histomorphometric evaluation

Results:

- 9/10 surgical sites had uneventful healing – membranes were maintained btw 24-38 weeks
 - o 1 site had a membrane exposure at 3 months – membrane was removed to avoid infection implants were clinically stable + maintained for final restoration
- At membrane removal + abutment connection: newly regenerated tissue similar to bone was visibly extending over the top of the implant shoulder and cover screw. A thin, soft tissue layer was present btw membrane + regenerated bone-like tissue
- All implants were clinically stable + loaded
- Mean bone to implant/ screw contact for composite graft
 - o 1st surgery = 3.29 mm
 - o Membrane removal = 0.5 mm
 - o Mean crestal bone regeneration = 3.15 mm
- Mean vertical bone of 3.85 mm in the autogenous group
- Composite sites had more granular PA vs autogenous bone sites
- Histological findings:
 - o Mineralized bone with different degrees of maturation + mineralization
 - o New bone formation + ongoing remodeling of autogenous bone + DBBM particles
 - o Apical portion: native lamellar bone with direct continuity with overlying regenerated bone
 - Graft particles were surrounded by mature lamellar bone
 - o Middle- coronal portion: both autogenous bone particles + DBBM had intimate contact with new mineralized bone
 - Woven bone, osteoid + bone marrow including blood vessels were more common
 - o Native bone was seen to bridge the DBBM particles with autogenous bone chips
 - o Osteoblast present on areas of demineralization

Conclusions

- Proper osseointegration was possible when implants were placed in regenerative bone using 1:1

- DBBM + autogenous bone
- DBBM / autogenous group had mean crestal bone regeneration of 3.15 mm
- Autogenous group had a mean crestal bone regeneration of 3.85 mm (NSSD)
- Mean percentage of regeneration bone 35.56% from 1:1 mixture with e-PTFE and 35.59% with autogenous + e-PTFE
- Autogenous bone + DBBM undergo resorption during healing period of 6-9 months
- Mean 10% DBBM volume in the biopsies
 - o DBBM undergoes very slow resorption + substitution with new bone

Topic: vertical ridge augmentation- GBR

Authors: Urban IA, Monje A, Nevins M, Nevins ML, Lozada JL, Wang HL

Title: Surgical management of significant maxillary anterior vertical ridge defects

Source: Int J Periodontics Restorative Dent 2016;36:329–337 .

DOI: 10.11607/prd.2644

Type: review

Reviewer: Erin Schwoegl

Purpose: to offer a classification based on 4 clinical scenarios and techniques to assist in achieving tension-free closure in vertical ridge aug (VRA) of ant atrophic maxilla

Classification:

Table 1 Classification and Description of Defects to Achieve Tension-Free Flap Closure in Anterior Maxillary VRA Procedures							
Classification	VRA^a	Horizontal ridge deficiency	Previous attempt	Vestibule	Periosteum	Proposed flap management	Difficulty^b
Type I	Shallow to moderate	Maybe	No	Deep	Native	Remote flap + periosteal incision + separation of elastic fibers + double-layer suture	Easy
Type II	Severe	Yes	Maybe	Shallow	Native	Safety flap + papilla shift technique + suborbicularis preparation + double-layer suture	Difficult
Type III	Shallow to moderate	Maybe	Yes	Deep	Scarred	Remote flap + periosteal incision with periosteoplasty + separation of elastic fibers + double-layer suture	Moderate
Type IV	Moderate to severe	Maybe	Yes	Shallow	Scarred	Safety flap + periosteal incision with periosteoplasty + papilla shift technique or periosteal excision + separation of elastic fibers + double-layer suture	Difficult

VRA = vertical ridge augmentation.

^aShallow ≤ 4 mm; moderate = 4–6 mm; severe ≥ 6 mm.

^bDifficulty with adequate preparedness and armamentarium.

Anterior Max VRA Flap Design Classification:

Type I: Deep vestibule and native periosteum

- Indication: pts w vertical defects up to 6mm or horizontal defects w normal vestibular depth, adequate KT, and intact, native periosteum
- Technical note: remote flap consists of crestal and VRI.
 - o Full thickness mid-crestal incision in KT
 - o 2 divergent vertical incisions placed at least 1 tooth from surgical site.
- Membrane fixation is critical; membrane fixated first on lingual/palatal using titanium pins or 3mm screws on at least 2 points.
 - o Bone graft placed into defect, membrane folded over and fixed w pins/screws.
 - o Membrane placement has to account for future bone height/width, and graft must completely fill space to support membrane
- Tips and pearls: flap advancement/double-layer suturing
 - o Once memb is secured, flap is mobilized in 2 stages.

- Periosteal sharp incision and separation of elastic fibers via blunt dissection.
- Sutured in 2 layers: first w horizontal mattress 4mm from incision, then single interrupted
 - Vertical incisions closed w single interrupted, starting apical to crestal

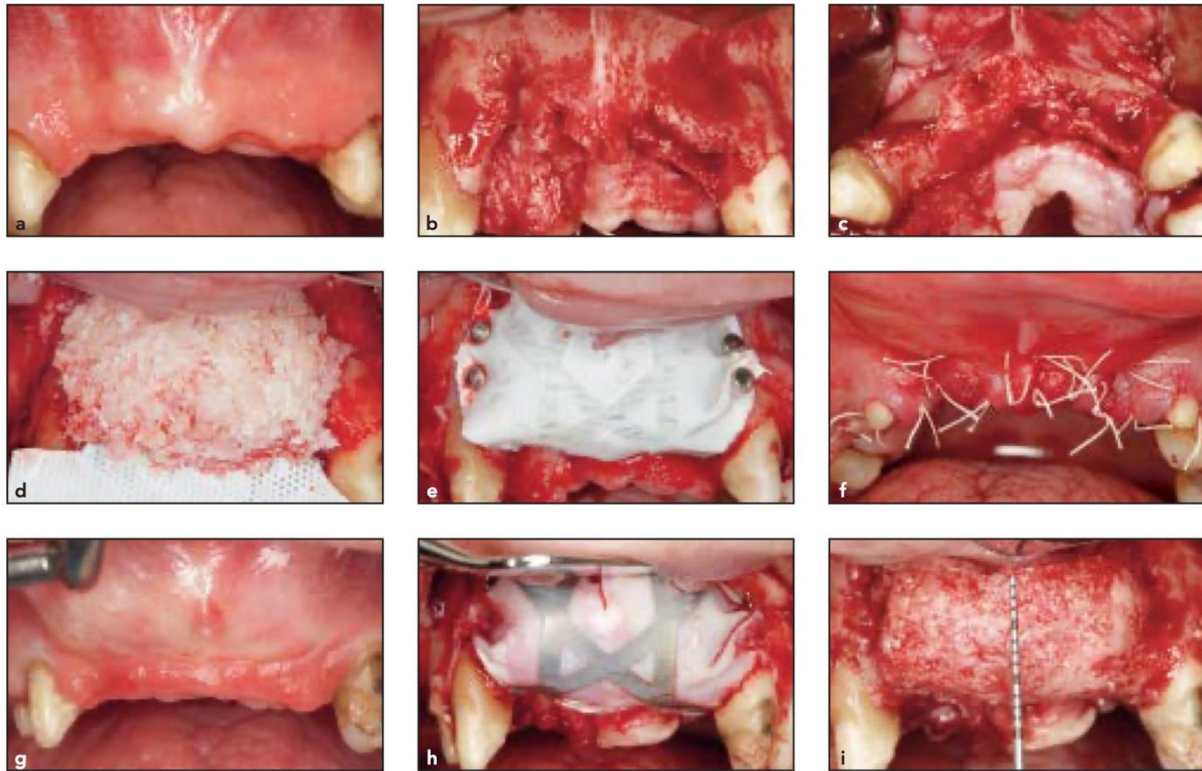
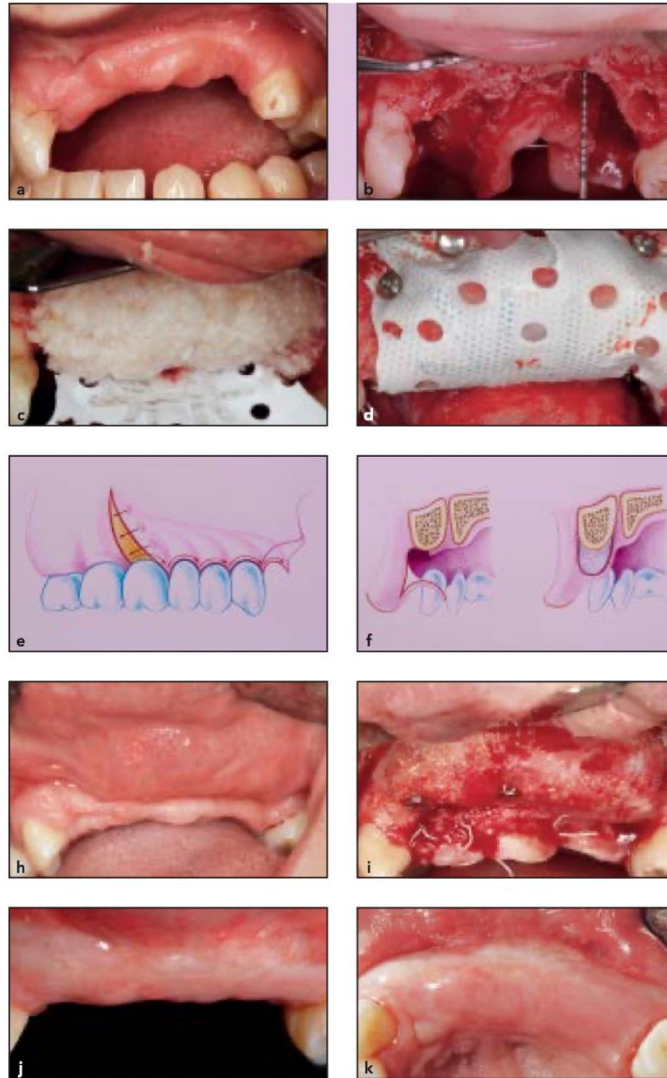


Fig 1 Type I: Deep vestibule and native periosteum. (a) Frontal view. Note the adequate presence of KM and the deep vestibule. (b) Bony architecture displaying a moderate vertical bone atrophy. (c) Occlusal view of the defect. (d) Placement of particulated anorganic bovine bone combined with autogenous graft (1:1 ratio). (e) Placement and stabilization of titanium-reinforced PTFE membrane to contain the defect. (f) Horizontal mattress and single interrupted sutures. (g) Clinical outcome after healing. Adequate vertical and horizontal bone augmentation are achieved in the presence of proper KM and vestibule depth. (h) Surgical reentry at 9 months. (i) Successful vertical and horizontal bone augmentation.

Type II: Shallow vestibule and native periosteum

- Indication: shallow vestibule from either
 - Previous sx w translocated MGJ but w/o scarring periosteum
 - May perform free ST graft to deepen vestibule and transform to Type I
 - Severe vertical ridge deficiency
- Technical
 - Safety flap (SF): extended remote flap used.
 - Flap design at least one tooth larger than Type I. 2 vertical incisions made 2-4 teeth away depending on defect severity
 - After periosteal release, can laterally position remote areas of flap ("free curtain flap") and shift each papilla mesially to overcome shallow vestibule.
 - Papilla shift technique: combo of coronally and laterally positioned flap

Fig 2 Type II: Representative case of shallow vestibule and native periosteum.
 (a) Labial view of a patient with advanced vertical defect and loss of the vestibule. (b) Labial view of the vertical bone deficiency. A safety flap was created with two vertical incisions placed three teeth behind the deficient ridge. (c) Labial view of the bone graft in place. (d) Labial view of the titanium-reinforced PTFE membrane in place. (e) Schematic drawing representing papilla shift technique. Note that while the papillae are shifted mesially, the vertical incisions are closed distally. (f) Lateral view of the final flap preparation using the suborbicularis. Final soft tissue closure after bone grafting. (g) A combination of papilla shift technique and suborbicularis muscle preparation was performed (arrows). The double layer suturing technique secures and stabilizes the grafting for adequate healing. (h) Occlusal view of uneventful healing after 9 months. Note: tooth 12 was extracted due to a fracture of the tooth. (i). Labial view of the regenerated ridge. (j) Labial and (k) occlusal views of the reconstructed anterior maxilla after vertical ridge augmentation and soft tissue reconstructive surgery. Keratinized tissue is visible and the vestibule has been reconstructed.



Type III: Deep vestibule and scarred periosteum

- Indication
 - Pts w shallow-moderate vertical defects and previous bone graft attempts that scarred the periosteum, but did not sig change MGJ
- Technical note:
 - Flap design as in Type I, but different periosteal release due to scarring
 - Periosteoplasty or partial periosteal excision via incision at line connecting apical ends of vertical incisions.
 - Continued coronally as an internal partial thickness incision, detaching scarred periosteum from deeper elastic fibers.
 - Depth of incision depends on periosteal thickness, but should reach elastic fibers.
 - Suturing undermined periosteum not recommended as sutures may strangle, resulting in ST complications

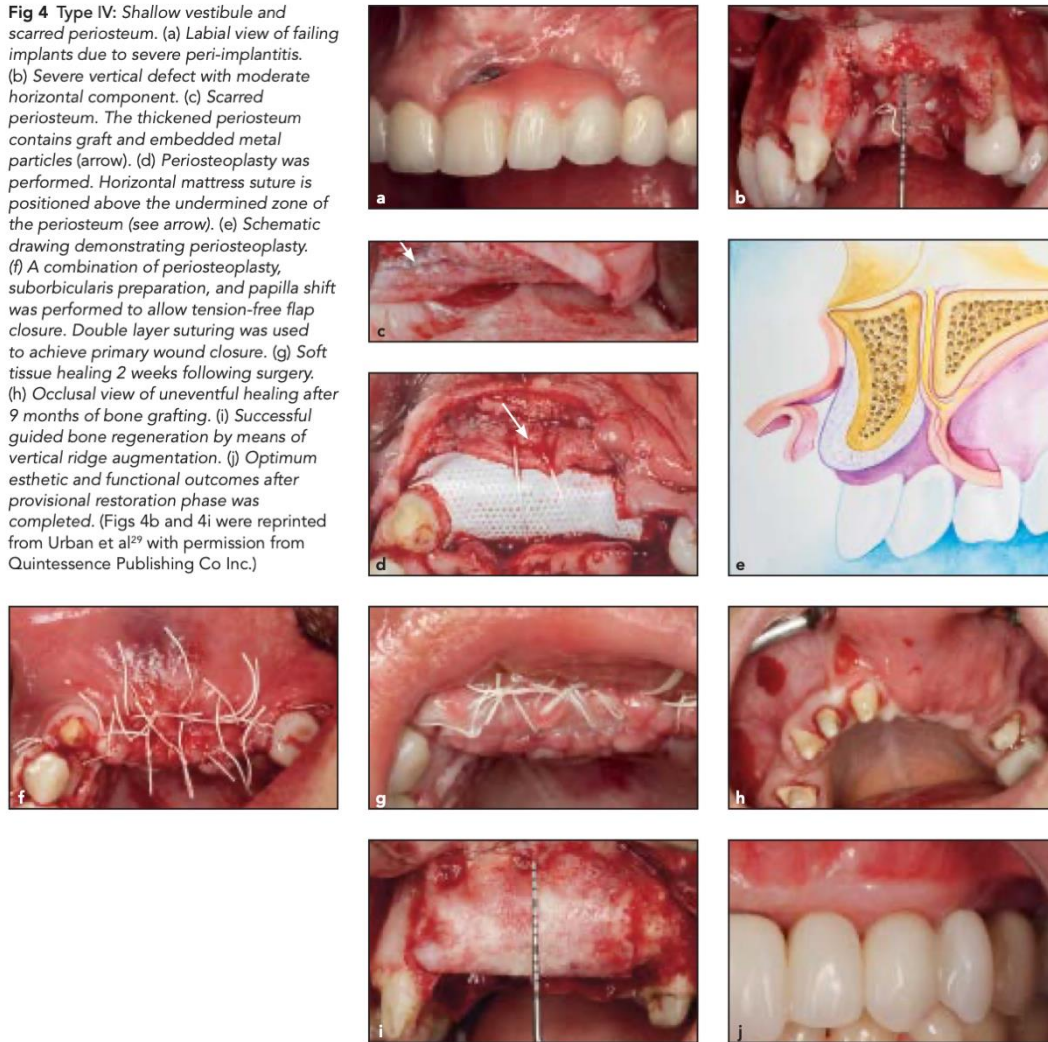


Fig 3 Type III: Deep vestibule and scarred periosteum. Patient was referred after several unsuccessful bone graft attempts. (a) Occlusal view of an exposed expanded polytetrafluoroethylene membrane. (b) Labial view after membrane removal and complete soft tissue healing. (c) Buccal and (d) occlusal views of moderate vertical and severe horizontal deficiency. Due to previous regenerative procedures, the periosteum is scarred. (e) Labial and (f) occlusal views of the bone graft in place. (g) A combination of periosteoplasty and suborbicularis preparation (arrow) was performed to allow tension-free flap closure. Double layer suturing was used to achieve primary wound closure. (h) Occlusal view of the soft tissue after 9 months of uneventful healing. (i) Labial view of the regenerated bone. (j) Labial view of the final reconstruction after 5 years of function.

Type IV: Shallow vestibule and scarred periosteum

- Indication
 - Pts w severe vertical ridge deficiency or shallow-moderate vertical defect with previous failed regenerative attempts
 - Translocated MGJ and scarred periosteum.
 - Bone graft or metal particles resorbed into periosteum; thickened, inflexible periosteum.
- Technical note:
 - Possible to do free ST graft to transform to Type III defect
 - Papilla shift technique combined w extended remote flap elevation and periosteoplasty/periosteal excision.
 - In general, Type IV defect management is a combo of Type II and III management

Fig 4 Type IV: Shallow vestibule and scarred periosteum. (a) Labial view of failing implants due to severe peri-implantitis. (b) Severe vertical defect with moderate horizontal component. (c) Scarred periosteum. The thickened periosteum contains graft and embedded metal particles (arrow). (d) Periosteoplasty was performed. Horizontal mattress suture is positioned above the undermined zone of the periosteum (see arrow). (e) Schematic drawing demonstrating periosteoplasty. (f) A combination of periosteoplasty, suborbicularis preparation, and papilla shift was performed to allow tension-free flap closure. Double layer suturing was used to achieve primary wound closure. (g) Soft tissue healing 2 weeks following surgery. (h) Occlusal view of uneventful healing after 9 months of bone grafting. (i) Successful guided bone regeneration by means of vertical ridge augmentation. (j) Optimum esthetic and functional outcomes after provisional restoration phase was completed. (Figs 4b and 4i were reprinted from Urban et al²⁹ with permission from Quintessence Publishing Co Inc.)



Conclusion:

- Tension-free closure required for successful VRA
- Need to consider vestibular depth, periosteum quality/integrity, and other anatomical characteristics to achieve tension-free closure

Topic: Vertical Ridge Augmentation

Authors: Urban IA, Monje A, Lozada J, Wang HL.

Title: Principles for Vertical Ridge Augmentation in the Atrophic Posterior Mandible: A Technical Review.

Source: Int J Periodontics Restorative Dent. 2017 Sep/Oct;37(5):639-645.

DOI: 10.11607/prd.320

Type: Review

Reviewer: Brook

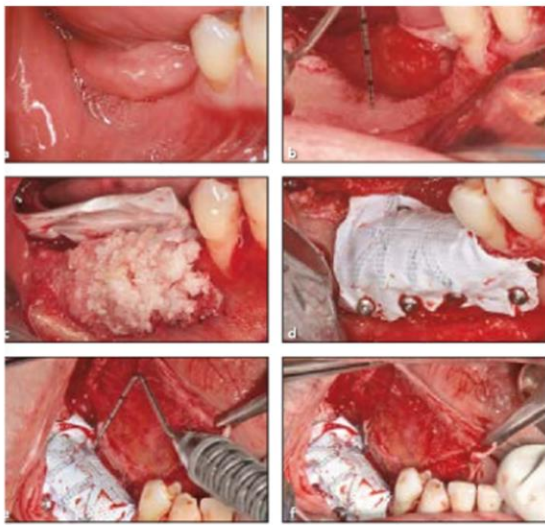
Thibodeaux

Keywords: n/a

Purpose: To review the most critical factors/considerations for vertical ridge augmentation success in the posterior atrophic mandible

Discussion:

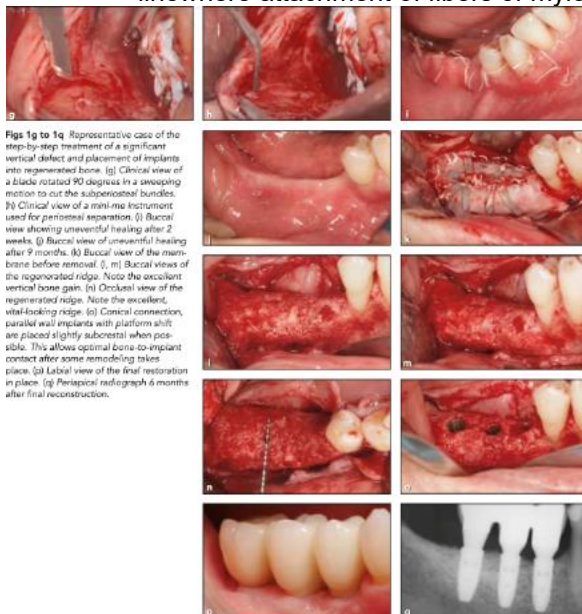
- Surgical Management of the hard and soft tissues will determine the success of the treatment



igs 1a to 1f Representative case of the step-by-step treatment of a significant vertical defect and placement of implants into regenerated bone. (a) Buccal view of a vertical defect of the posterior mandible. Note that the floor of the mouth is higher than the dge. (b) In addition to the severe vertical bone defect, the ridge was also knife edge. (c) Particulated autogenous bone graft mixed with anorganic bovine bone mineral is placed in the ridge. (d) Buccal view of the titanium-reinforced high-density polytetrafluoroethylene membrane secured over the graft with titanium tacks. Note that the membrane is not in contact with the neighboring tooth. (e, f) Buccal view of the released lingual flap. Note the

- The Safety Flap

- o Safety flap design will provide enough soft tissue to accommodate the increased dimension of the grafted ridge
- o Full thickness midcrestal incision is made in the KG with 15 blade
- o Distal extension of the crestal incision ends within 2mm of the retromolar pad. Distal oblique vertical incision is made toward the coronoid process of the mandible for sx access. MB vertical incision made at least one, pref 2 teeth away from the sx site. ML a 3-4mm incision is made at line angle of the most distal tooth in front of the defect. FTF reflected beyond MGJ, at least 5mm beyond the bone defect. L flap elevated to the mylohyoid linewhere attachment of fibers of mylohyoid muscle can be seen.



Figs 1g to 1q Representative case of the step-by-step treatment of a significant vertical defect and placement of implants into regenerated bone. (g) Clinical view of a blade rotated 90 degrees in a sweeping motion to cut the subperiosteal bundles. (h) Clinical view of a mini-me instrument used for periosteal separation. (i) Buccal view showing uneventful healing after 2 weeks. (j) Buccal view of uneventful healing after 9 months. (k) Buccal view of the membrane before removal. (l, m) Buccal views of the regenerated ridge. (n) Occlusal view of the regenerated ridge. (o) Buccal view of the regenerated ridge. (p) Buccal view of the regenerated ridge. (q) Buccal view of the regenerated ridge.

- Recipient Site Preparation

- o Bone bed is prepared w/ multiple decorticalization screw holes using a small round bur

- Membrane will be molded owing to the titanium reinforcement and densely filled graft will provide enough support. Number and location of tenting screws is based on extent of defect grafted, but generally 2-3 should be enough for large defects.
- Membrane Adaptation
 - Appropriate size membrane selected and trimmed so that it totally covers the volume of the graft and edges will not be in contact with natural teeth and should rest on at least 2mm of adjacent bone. Membrane fixation is a critical aspect of this procedure because the graft must be immobilized. Membrane stabilized on the L/P side first using titanium pins or 2mm titanium screws on at least 2 points. If placement of the first lingual pin is difficult- a temporary pin can be placed on the crest behind the last tooth, first. Once membrane stability is ensured- temporary pins removed.
- Bone Grafting
 - Autogenous particulate bone graft harvested from mandibular ramus- with bone scraper or back action chisel mixed with long lasting grafting material is placed into defect. Membrane is folded over and stabilized with additional titanium pins/screws
- Modified Lingual Flap Advancement
 - Based on location of attachment of mylohyoid muscle and on protection of vital anatomical landmarks- lingual n and sublingual artery.
 - 3 zones of interest
 - First zone: has to be handled so that n. is protected and the flexibility is achieved with blunt dissection. Achieved through tunneling and lifting of the retromolar pad
 - Second zone: important that the muscle is not reflected from the mandible. Flap advancement achieved with blunt dissection protecting key anatomical landmarks- leads to detachment of soft tissue from intact mylohyoid muscle
 - Third zone: region in which membrane exposure is most typical to occur. Horizontal hockey stick periosteal semi-blunt incision used here.
- Buccal Flap Advancement
 - Periosteal-elastic technique recommended due to potential for n. injury, extensive bleeding and tissue damage that can impair vascularization of flap.
 - Performed by making gentle periosteal incision w/o invading CT below it. Mental n. protected. Subperiosteal bundles are released from elastic fibers and elastic fibers are separated using the Prichard periosteal or minime instrument.
- Flap Closure
 - Flap sutured in two layers
 - First: horizontal mattress sutures placed 5mm from incision line
 - Second: single interrupted sutures to close flap edges.
 - Flap margins are averted- intimate CT to CT contact provides barrier to prevent exposure of membrane.
 - Vertical incisions closed with single interrupted sutures from apical area to crestal area- preferably with PTFE sutures



Fig 2 Schematic drawing representing the occlusal view of the final fixation of the membrane.



Fig 3 Schematic drawing representing the occlusal view of the double layer closure of the flap.

- Simultaneous versus staged approach
 - Simultaneous VRA and DI placement when <4mm of VRA needed. Staged approach when ≥ 4 mm VRA needed.
 - Staged augmentation recommended due to:
 - Safety: complications such as membrane exposure or low-grade infection. If implant has been placed simultaneously- bacteria may adhere to the implant and cause complete loss of the graft and implant causing a worse scenario than

- baseline.
 - Healing: staged approach allows for more time for maturation of the regenerated bone prior to placing and loading of the implant. Placing DIs may interfere with and slow down new bone formation.
 - Soft tissue: healing abutments are placed when the membrane is retrieved for simultaneous approaches, but in many cases the KM is minimal. If KM is lacking- increasing it by ST grafting on the B/L is challenging, leading to a less favorable long-term prognosis of these implants due to increased subjection to inflammation.
- Crestal bone changes
 - Regenerated posterior mandible is a region where patients have incr risk of progressive peri-implant marginal bone loss.
 - Soft tissues are usually thinner than required for biologic width. Biological width is formed at the expense of the marginal bone loss post prosthesis delivery.. Early bone loss is regarded as physiological and should be controlled to detect progressive pathologic bone loss. Soft tissue grafting or modified implant-abutment (platform switching) should be considered.
 - Certain implant systems are more challenging to place implants subcrestally. Implant is placed supracrestally and with differing implant roughness assuming more difficult oral hygiene in the mandibular posterior region- this causes DI to be more prone to biofilm attachment on the surface which can lead to peri-implantitis
- Mucogingival considerations
 - Adequate amount of KM around teeth and DIs is necessary in order to preserve health and stability of ging/mucosal tissues
 - Preform FGG prior to second stage- not realistic to graft on L side during or after abutment installation.
 - If KM <4mm- decide if reconstruction absolutely necessary. Incision at UNC made 2mm B from the L MGJ to ensure enough KM. or FGG on buccal side at this point.
 - If >=4mm of KM- distribute KM evenly during UNC
- Presence of Dentition: can be a drawback in flap advancement. Other treatment options may be advised.
- Defect Morphology
 - More favorable results seen with concave topography
 - Less bone gain expected with flat/convex topography.

Conclusions: In order to determine treatment feasibility for patients, critical factors should be assessed and controlled during initial therapy. Anatomical landmarks must be understood in order to execute vertical ridge augmentation of the atrophic posterior mandible. In order to avoid high complication rates and attain tension free flap closure, adequate sequencing of techniques must be used.

Topic: d-PTFE vs. Ti-mesh and collagen membranes

Authors: Cucchi A, Bettini S, Ghensi P, Fiorino A, Corinaldesi G

Title: Vertical ridge augmentation with Ti-reinforced dense polytetrafluoroethylene (d-PTFE) membranes or Ti-meshes and collagen membranes: 3-year results of a randomized clinical trial

Source: Clin Implant Dent Relat Res. 2023 Jan 16.

DOI: 10.1111/cid.13173

Reviewer: Amber Kreko

Type: RCT

Keywords: alveolar bone atrophy, alveolar bone loss, alveolar ridge augmentation, bone regeneration, dental implant

Purpose: To evaluate hard and soft tissue parameters around implants placed in augmented posterior mandible, comparing Ti-reinforced d-PTFE membranes with Ti-meshes covered with collagen membranes, after 3 years of follow-up

Material and methods:

- 40 patients needing GBR in posterior mandible with vertical bone defect ≥ 2 mm.
- Group A: Ti-reinforced d-PTFE membrane (Cytoplast)

- Group B: titanium mesh (Trinon Titanium) covered by cross-linked collagen membrane (Osseoguard)
- Surgery:
 - o Tapered implants (BT SAFE) placed in ideal position with protrusion of most coronal portion of the implants from the alveolar ridge showed amount of vertical bone regeneration.
 - o Cortical perforations done and mix of 50% autogenous and 50% allograft (EnCore) used to fill PTFE or Ti-mesh. Barrier membrane was fixed using osteosynthesis mini-screws and primary closure was achieved.
 - o After 9 months, sites were reopened, barrier membrane was removed, implants uncovered, and healing screw placed.
 - o Sites were treated with CTG for soft tissue management. After 3 months (T2), patients received restoration. After 1 year (T3) and 3 years (T4), clinical and radiographic parameters were collected.

Results:

- Final sample size at 3 years follow up was 28 patients with 79 implants: group A – 15 patients with 45 implants; group B – 13 patients with 34 implants
- Soft tissue augmentation was performed in 21 patients: group A 10 patients with 26 implants; group B – 11 patients with 30 implants
- MBL was 0.73mm in group A and 0.71mm in group B.
- Interproximal bone loss was 0.64mm in group A after 3 years and 0.40mm in group B.
- Values of IBL showed a SSD between two study groups after 3 years favoring group B
- Both groups showed increase in thickness of keratinized tissue and width of keratinized tissue.

Conclusions: Vertical ridge augmentation in posterior mandible had stability of peri-implant bone levels and IP bone levels up to 3 years using both Ti-reinforced PTFE and titanium mesh with collagen membrane. Correct maintenance protocol is needed to preserve peri-implant health.

Topic: Ridge Augmentation Complications

Authors: Gallo P, Díaz-Báez D.

Title: Management Of 80 Complications In Vertical And Horizontal Ridge Augmentation With Non resorbable Membrane (d-PTFE): A Cross-Sectional Study

Source: Int J Oral Maxillofac Implants. 2019 July/August;34(4):927–935

DOI: 10.11607/jomi.7214

Reviewer: Tam Vu

Type: Clinical

Keywords: Ridge Augmentation, complications, infection, exposure, bone grafting

Background

- **Fontana 2011** Clinical Classification of Complications in GBR of Nonresorbable Membrane
 - o Healing complications:
 - Class I: Small membrane exposure (≤ 3 mm) w/out purulent exudate
 - Class II: Large membrane exposure (> 3 mm) w/out purulent exudate
 - Class III: Membrane exposure **with** purulent exudate
 - Class IV: Abscess formation w/out membrane exposure
 - o Surgical complications:
 - A: Flap damage
 - B: Neurologic complications
 - C: Vascular complications

Purpose: to describe the management of complications in vertical and horizontal ridge augmentation with titanium-reinforced high-density polytetrafluoroethylene (d-PTFE) nonresorbable membrane

Material and methods:

- Complications managed between 2010 – 2017 of GBR using d-PTFE (Cytoplast Ti-250)

Complication Management

Management of Class I Healing Complications

- Monitored weekly to clean membrane with CHX 0.12%, digital pressure near exposure borders to look for purulent exudate
- Postop instructions: gentle brushing and CHX gel 0.12% BID
- Immediate appearance exposure (<10 days) – leave membrane in place for 6 – 8 weeks then remove
- Medium appearance exposure (<2 mo) – leave membrane for 6 – 8 weeks then remove
- Late appearance exposure (>2 mo) – leave membrane as long as possible until 9th month, given no infx
- Follow up – no graft loss

Management of Class II Healing Complications

- Same protocol as Class I complications, as long as no infx – membrane remain for at least 6 – 8 weeks
 - After 6 – 8 weeks, if exposed membrane had excess plaque – remove to prevent infx
- Postop instructions: clean with moist gauze dipped in CHX TID
- Follow up – no graft contraction

Management of Class III Healing Complications

- Rx'ed abx (amox/clavulanic acid 1g q12h for 7 days)
- Immediate membrane removal
- Clinical signs: pain, purulent exudation upon palpation, or fistula
- Follow up – graft contraction and replace of soft tissue under membrane
 - Purulence within first 2 mo saw most graft loss

Management of Class IV Healing Complications

- Clinical symptoms: pain, purulent exudate in fistula or gingival sulcus around adjacent teeth. Presents with inflammation and swelling – if after 15 days – considered infection
- Immediate removal of membrane, soft tissue, and mobile graft particles and placement of collagen membrane
- Continue abx Rx from sx

Management of Surgical Complications According to Fontana Classifications

- Flap damage after graft and membrane fixation – tissue was sutured over d-PTFE membrane and achieve primary closure, however pts still presented with exposure (class I or II complication) at 1st follow up, who were then treated according to protocol.
- Neurologic complications (transitory parasthesia of mental nerve) – treated with daily intramuscular injections of vitamin B1 + B6 + B12 (Neurobion Merck) for 4 days
 - Symptoms improved after tx

Classification of Exposure According to Sagittal Location

- Vestibular
- Crestal

- Lingual/palatal

Classification of exposure according to coronal distance from alveolar ridge

- ≤3 mm from most coronal part of alveolar ridge
- >3 mm from most coronal part of alveolar ridge
- Combined, begins at coronal part of alveolar ridge and exceeds MGJ

Results:

- 80 complications evaluated
- Complication rate by sextant
 - Anterior maxilla 43.75% (35/80)
 - Mandibular left 20.0% (16/80)
- Majority of complications happened before 2 month post op – 70% (56/80)
 - 13.75% (11/80) happened between 2 – 4 mo
- Fontana classification, complication rate
 - Class I: 22.5%
 - Class II: 22.5%
 - Class III: 23.75%
 - Class IV: 31.45%
- Neurologic complications: 3.75%
- Vascular complication: 1.25%
- Mean exposure size: 4.73 mm
- Sagittal location of exposure:
 - Coronal part alveolar ridge – 43.64% (24/55)
 - Vestibular area: 43.64%
 - Lingual area: 10.91%
 - Palatal area: 1.82%
- **Exposures on coronal part of alveolar ridge had greater chance of abscess formation**
- SSD found between exposures w/ or w/out purulent exudate relative to coronal location of exposure

Conclusion:

- Infections are major cause of bone loss in GBR
- Proposed protocol to manage complications may help prevent total graft loss
- Location of membrane exposure is critical, more abscess formation at the crest (due to dental plaque accumulation)

Topic: Vertical Ridge Aug

Authors: Urban IA, Montero E, Amerio E, Palombo D, Monje A.

Title: Techniques on vertical ridge augmentation: Indications and effectiveness.

Source: Periodontol 2000. 2023 Oct;93(1):153-182

DOI: 10.1111/prd.12471

Reviewer: Daeoo Lee

Type: Review

Keywords: GBR, block graft, distraction osteogenesis

Purpose: to describe the different approaches advocated for vertical ridge augmentation along with the indications and the evidence that support its use.

Discussion: See Figures 1 and 2 for GBR, Figure 3 for Shell technique

	Guided Bone Regeneration	Block grafting: Onlay, inlay, and cortical plates	Distraction Osteogenesis
Biological foundation	Principles: - Primary wound closure for aseptic healing - Angiogenesis - Space creation and maintenance - Stability of the clot	Principles: - Primary wound closure for aseptic healing - Angiogenesis - Space creation and maintenance from the bone block, which allows the proliferation of bone-forming cells during healing. Owing to the solid nature of bone block, space is created by the graft and no further device for space creation is required. - Stability of the clot	Based on the segmentation of the atrophic bone and on the progressive displacement of the bone segment and the attached soft tissues in a coronal direction to create a secluded regenerative chamber where new bone and soft tissues are formed throughout the distraction process
Technical Note	- Very technique-sensitive procedure - Moldable barrier membrane + bone substitute + sufficient volume - Flap design should account for the fact that primary tension-free closure will need to be reached over an increased dimension after the bone graft has been placed into the defect. - Influencing factors: depth of the vestibule and the severity of the alveolar defect Anterior Ridge - Remote flap: crestal + vertical releasing - Recipient site preparation: decortication screw holes - Membrane adaptation: titanium-reinforced	- Soft tissue management: "free curtain flap" and papilla shift technique - the zone-specific lingual flap advancement technique; - the vestibular shifted flap design; - the suspended external-internal suture; - the tunnel approach - Hard Tissue management - Flap elevation -> bone defect degranulation and decortication - Bone block harvested from the mandibular ramus, chin, iliac crest, or	Steps and principles: - Segmental osteotomy with horizontal apical cut with vertical osteotomy. - Distractor fixated. - Latency period of 3, 5, or 7 days, depending on the surgical site. - Distraction rate of 1.0 mm per day (0.5-2.0 mm). - Distraction through continuous force application is best, albeit a device activation twice a day is more practical and allows for better patient compliance. - Consolidation should be extended until a cortical outline can be seen radiographically across the distraction gap,

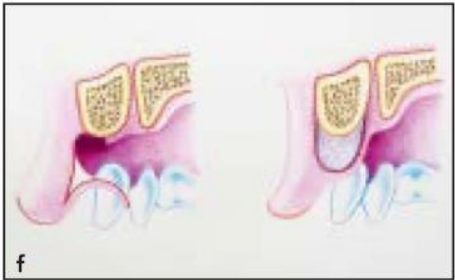
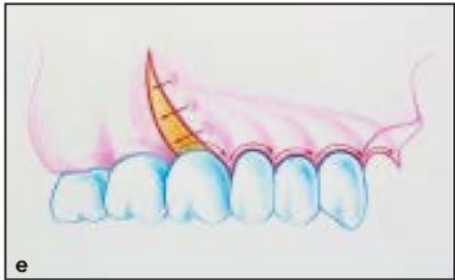
	PTFE OR resorbable membrane with tenting screws • Membrane fixation: titanium pins • Bone grafting: autogenous + bone substitute. Membrane folded over and stabilized with additional titanium pins/screws. • Free curtain flap and papilla shift technique: 2 vertical incision 2-4 teeth away from defect. Laterally shift papilla mesially to address shallow vestibule. • Flap closure: Sutured in 2 layers. First layer is closed with horizontal mattress sutures placed 5mm from incision line, and then single interrupted sutures are used to close the edges of the flap. Posterior Ridges • Safety flap: midcrestal incision + distal oblique vertical incision • Recipient site preparation: similar to anterior ridge prep • Membrane adaptation: similar to anterior ridge prep • Membrane fixation: similar to anterior ridge prep • Bone grafting: similar to anterior ridge prep • Lingual flap advancement:	parietal calvarium are modeled to obtain adaptation to the recipient site and then rigidly fixed with titanium miniscrews. ○ Sharp edges from the bone block are carefully removed to avoid any risk of flap perforation. ○ Remaining gaps between the bone block and recipient site are filled with autogenous bone chips collected during the harvest of the bone block. ○ A layer of slowly resorbable bovine bone matrix mixed with autogenous bone chips can be placed over the grafts and stabilized with collagen membranes, in order to reduce the risk of bone resorption. ○ After the completion of the reconstructive phase, periosteal	which usually requires 6 weeks. Indications • Distraction osteogenesis is indicated prior to the implant placement in the case of severe vertical discrepancies in order to regenerate the bone. • Whenever it is desired to reduce the intermaxillary distance for better esthetics and function. • In scenarios where it is desired to augment the hard and the soft tissues simultaneously. • In highly damaged soft tissues where flap advancement is not feasible. Limitations • When the residual bone volume required for the fixation of the distractor and also the transported bone fragment dimensions are insufficient, it should be taken into account that a residual vertical bone height of at least 6-8 mm is usually required and that small transported fragments (eg, single-tooth defect) may potentially lead to more complications due
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	○ The first zone is around the retromolar pad where the lingual nerve is running in close proximity. Tunneling and lifting on the retromolar pad is indicated. ○ The second zone is located in the molar region where the mylohyoid line is attached closer to the crest. Mylohyoid detachment by means of blunt dissection is indicated. ○ The third zone is the premolar region where the muscle is attached deep and there is a deep periosteal attachment of the soft tissue to the lingual side of the mandible. A horizontal hockey stick periosteal	releasing is performed and first intention closure is achieved. ○ Surgical reentry is performed between 4 and 12 months after surgery, to allow the placement of dental implants. • Shell technique: see fig. 3 • Inlay bone block Indications • Simultaneous grafting and implant placement. • Extensive vertical defects in partially or totally edentulous patients, especially in the mandible. Limitations • Limited amount of intra-orally available bone. • Higher morbidity than with the use of particulate bone substitutes.	to vascular impairment. • Whenever it is desired to augment the ridge in both the vertical and horizontal directions. • Posterior ridges are often more complicated due to access and the morphology of the ridges.
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	incision is indicated. • Flap closure Indications • Simultaneous grafting and implant placement • Localized vertical deficiency of partially edentulous Limitations • Originally utilized for 1-3 teeth defect. • Posterior mandibular vertical defects when the infra-al nerve is exposed should not be treated with bone grafts placed directly on the exposed nerve • Limited autogenous bone (need at least 50% of autogenous)		
Effectiveness	Vertical bone gain • Non-resorbable: 4.42mm • Resorbable: 4.19mm • Collagen mem: 2.66mm	• More recent data seem to support better results for the shell technique versus classical onlays for vertical ridge augmentation.	• demonstrated that this surgical technique is able to <u>vertically regenerate</u> a considerable amount of bone, ranging between 5 and 12 mm depending on the original extent of the defect
Post-Op Complications	• Frequency of exposure: 12% • Beitilitum et al: exposure of cross-linked collagen membrane -> 50% less bone regeneration	• Exposure of the graft, with or without infection • Temporary paresthesia, pulp necrosis of lower incisors	• <u>High percentage of complications</u> is associated with this procedure, and some of them may lead to the failure of the vertical regeneration, such as device failure/mechanical problems, fracture of the basal bone/transport segment, and bone resorption

Long-Term Predictability	- Heterogeneity in data - average bone loss of about 1 mm is expected after the first year of loading and a substantial stability of the marginal bone level could be assumed after this period.	Marginal bone loss is below 1 mm in periods up to 10 years when autogenous bone following the “shell technique” have been used	Not much studies but studies show stable in 3 years study
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- (Urban 2016) “free curtain flap” and papilla shift technique: after periosteal incisions and elastic fiber separation, the clinician can laterally position the remote areas of the flap (referred to as the “free curtain flap”) and shift each papilla mesially to overcome the shortcomings of the shallow vestibule. This combination of coronally and laterally positioned flap is called the papilla shift technique



- Zone Specific Lingual Flap (Urban 2018)

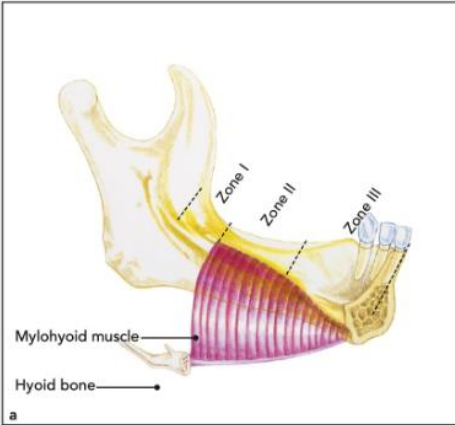
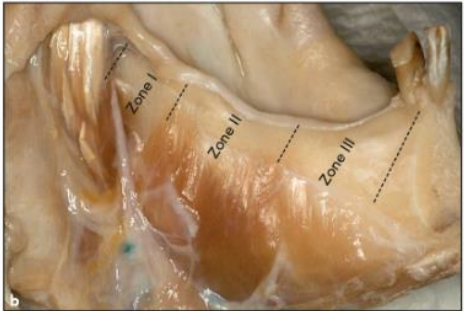


Fig 1 Illustration (a) and photograph (b) showing the anatomy of the typical insertion of the mylohyoid muscle on the internal aspect of the mandibular body and the location of zones I, II, and III.



- (De Stavola 2021) Vestibular shifted flap (See Fig. 3B)

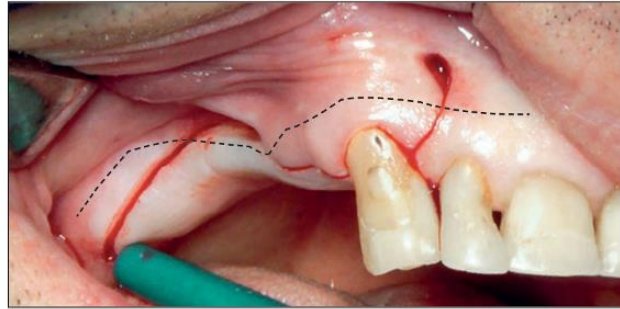


Fig 7 Relationship between mucogingival junction (black dotted line) and the visible incision line. Note that the incision crosses the mucogingival junction for a short mesiodistal span in correspondence to the maximum vestibular shifting.

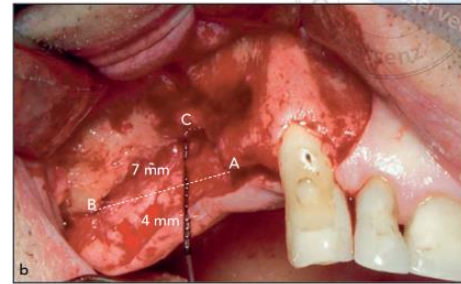
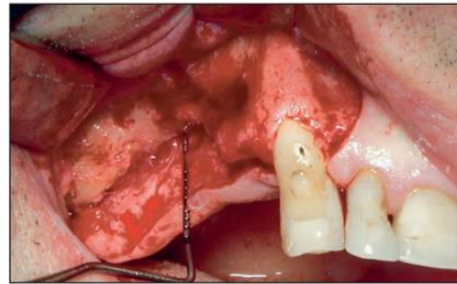
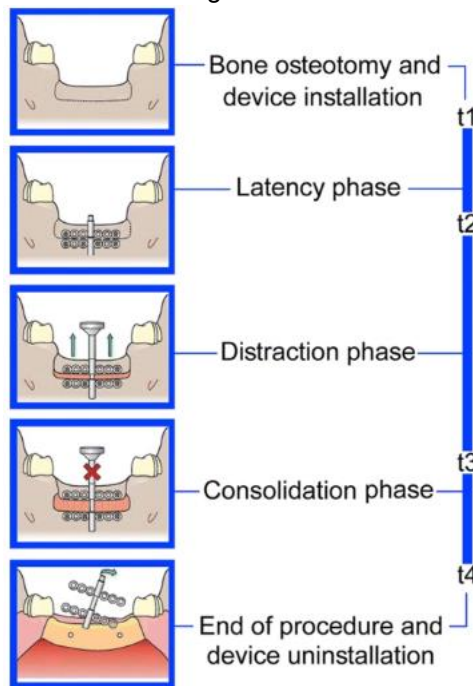


Fig 8 (a) Clinical view after palatal and vestibule flap elevation. Note the coronal position reached by the palatal flap in relation to the vertical defect. (b) The tissue extends about 4 mm beyond the target of the vertical bone augmentation (the line between A and B). A = mesial bone peak; B = distal bone peak; C = point of maximum vertical deficiency (7 mm).

Distraction Osteogenesis



Topic: Short implants and grafting less

Authors: Misch CM. and Polido WD.

Title: A "Graft Less" Approach for Dental Implant Placement in Posterior Edentulous Sites

Source: Int J Periodontics Restorative Dent 2019;39:771–779.

DOI: 10.11607/prd.4414

Reviewer: Cyrus J Mansouri

Type: Review

Keywords: augmentation, graft less, short implant, treatment planning

Background:

Vertical bone augmentation is more invasive and less predictable with varying success rates according to the clinician's surgical expertise. Thus, a trend towards more minimally invasive options for implant planning has developed, such as shorter and narrower implants with advanced microtextured surfaces, improved implant-abutment connection, stronger titanium alloys, and virtual implant planning. These more minimally invasive approaches decrease chances of complications, morbidity, and treatment time.

Purpose:

To discuss "graft less" treatment philosophy, emphasizing the use of less-demanding augmentation techniques for the purpose of placing short implants in the atrophic posterior site.

Short implant outcomes

Recent evidence demonstrates short implants with textured surfaces to have similar survival rates to standard-length implants.

- Systematic review by Lemos 2016:
 - o 97.3% survival for standard length and 96.1% for short
 - o No SSD between standard and short implants in posterior regions
 - o No SSD in the maxilla or mandible.
 - o No SSD in marginal bone loss.
 - o Implants < 8.0 mm demonstrated slightly lower survival rates than standard implants.
 - o Short implant failures are typically early failures due to inadequate primary stability.
- Another systematic review (Ravidà 2019) was on extra short implants < 6 mm:
 - o Mean survival rate of 94% (90% in maxilla; 96% in mandible)
 - o Maximum bone loss of 0.53 mm.
 - o Discretion should be used when using extra-short implants, especially in the maxilla.
- Biomechanical studies have shown implant crown height (including abutment) is more influential to influence implant survival than implant length.
 - o C/I ratio does not seem to influence marginal bone loss or survival rate.
 - o Greater implant crown height may be a risk factor for screw loosening and abutment fractures in posterior areas.
 - Implant crowns may be splinted for where short implants are replacing multiple teeth.
- Future investigations should compare short implants placed in native bone with implant placed in augmented sites; this would give more accurate comparative outcomes than most current studies comparing both longer and short implants placed in native bone.

"Graft Less" Vertical Bone Augmentation

Posterior maxilla

In the posterior maxilla, the sinus floor often limits available bone for implant placement. This has been managed by sinus bone grafting via a lateral window approach to allow for the placement of long dental implants, especially when implants < 10 mm historically had lower survival rates in the posterior maxilla.

- Modern implantology has allowed us to achieve similar survival rates for short implants placed in native bone below the sinus and longer implants placed in grafted sinuses.
- Sinus bone grafting has a higher incidence of complications, greater morbidity and cost, and additional surgical and healing time.
- Use of shorter implants also may better facilitate a transcrestal approach for sinus floor lifting.
- Extra-short implants have demonstrated favorable outcomes in the posterior maxilla; however, a SR found implants < 8 mm placed with the osteotome technique had lower survival rates than longer implants.

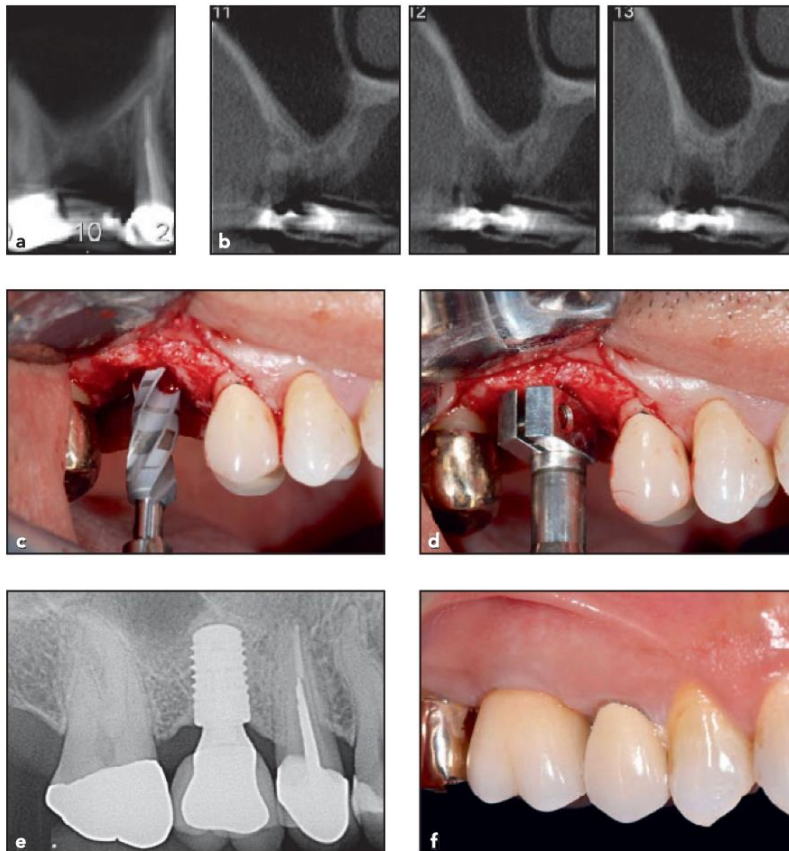


Fig 1 Preoperative cone beam computed tomography scan of (a) the right posterior maxilla and (b) the first molar site. (c) The implant osteotomy is prepared short of the sinus floor. (d) An osteotome was used to perform an internal sinus lift and insertion of bovine bone mineral. (e) Postoperative periapical radiograph and (f) clinical view of the 8.0-mm implant restored with a screw-retained crown at 3 years.

Posterior mandible

Vertical bone grafting in the posterior mandible is more challenging and less predictable than sinus grafting in the maxilla. Available vertical augmentation modalities are guided bone regeneration, onlay block grafting, titanium mesh grafting, interposition grafting, or distraction osteogenesis, without consensus on a superior method.

- The most common complication is wound dehiscence, which may compromise bone formation or result in complete failure.
- Several studies have supported using short implants in the atrophic posterior mandible as preferred to longer implants with bone augmentation techniques, due to augmentation groups facing more complications.
- Respecting the mandibular canal by 2 mm is still important while placing extra-short (6.0 mm) dental implants.
- The clinician may also aim for a modest gain in vertical bone height with the placement of short dental implants to obtain more predictable and consistent results.

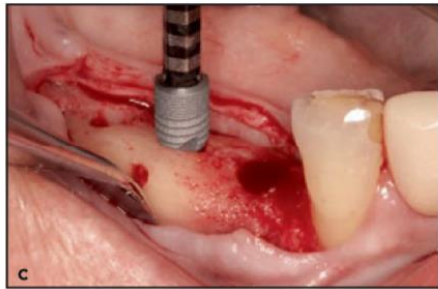
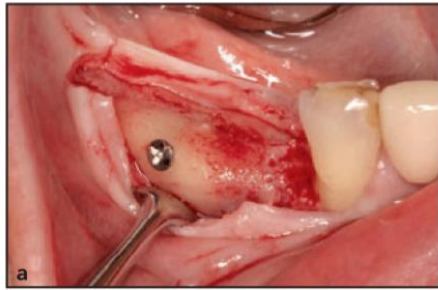


Fig 2 (a) A ramus cortical bone graft was used for horizontal augmentation of the atrophic posterior mandible. (b) Cross-sectional image of the healed bone graft. (c) Clinical and (d) cross-sectional views of a 6.0-mm implant inserted into the healed bone graft in the posterior mandible. (e) Three dental implants were then placed into same healed bone graft and (f) restored with splinted crowns. (g) A postprosthetic periapical radiograph of the implants.



“Graft Less” Horizontal Bone Augmentation

Horizontal is more predictable than vertical augmentation, and may be achieved by GBR, block bone grafting, titanium mesh grafting, or ridge expansion.

- Grafting horizontally and placing shorter dental implants represents a more predictable method compared to vertical grafting with the placement of longer dental implants.

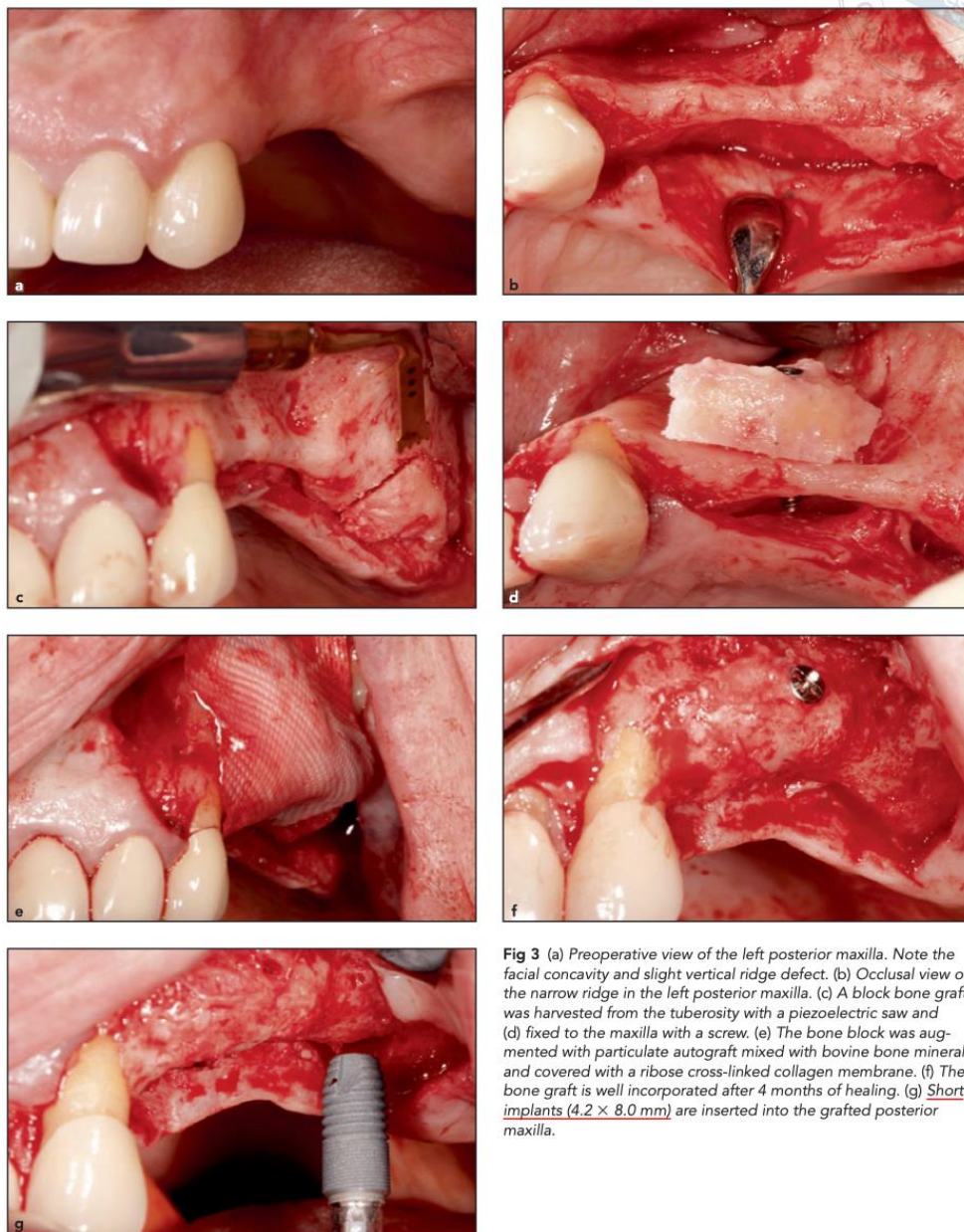


Fig 3 (a) Preoperative view of the left posterior maxilla. Note the facial concavity and slight vertical ridge defect. (b) Occlusal view of the narrow ridge in the left posterior maxilla. (c) A block bone graft was harvested from the tuberosity with a piezoelectric saw and (d) fixed to the maxilla with a screw. (e) The bone block was augmented with particulate autograft mixed with bovine bone mineral and covered with a ribose cross-linked collagen membrane. (f) The bone graft is well incorporated after 4 months of healing. (g) Short implants (4.2 × 8.0 mm) are inserted into the grafted posterior maxilla.

Conclusion:

The use of short implants for prosthetic support offers clinicians less complex and more predictable methods for tooth replacement of posterior teeth. When inadequate bone is available, bone augmentation may be planned for simultaneous use of short dental implants to graft less.

Topic: Vertical Ridge Augmentation

Author: Urban I, Montero E, Sanz-Sánchez I, Palombo D, Monje A, Tommasato G, Chiapasco M.

Title Minimal invasiveness in vertical ridge augmentation

Source Periodontol 2000. 2023 Feb;91(1):126-144.

DOI: 10.1111/prd.12479.

Type: Review

Reviewer: Veronica Xia

Keywords: vertical bone augmentation, surgical techniques, digital planning, complications

Purpose:

- Review most recent surgical strategies used in vertical bone augmentation to reduce the

invasiveness and complications

Materials and Methods:

- Electronic search, leading to the inclusion of 16 articles

Discussion:

- Thorough treatment planning and identification of less invasive alternatives prior to surgery
- Patient preparation: eliminate sources of potential infection, extraction of hopeless teeth, ensure proper oral hygiene, smoking cessation highly recommended, glycemic control in diabetic patients

Surgical Techniques

- Minimally invasive split-thickness flap without periosteal releasing incisions proposed for vertical GBR
 - Double flap incision: mucosal layer separated from periosteal layer, which is used to stabilize the regenerative site using periosteal sutures
 - Greater flap advancement with less morbidity
- Split thickness flap without vertical releasing incisions
 - Full thickness flap to MGJ, then change to split thickness
 - Periosteum elevated from bone and double layer suturing with horizontal mattress to cover membrane
 - Tension-free closure required
- Autogenous bone blocks used as shells and the gaps are filled with autogenous bone chips
 - Blocks harvested from external oblique ridge
 - Tunnel technique: single vertical incision distal to mesial tooth of the defect
- Cortical tenting/tent pole technique
 - Increase ridge width/height with autologous bone blocks/combination of bone substitutes with barrier membrane
 - Titanium screws maintain dimension
- Primary closure is crucial
 - Palatal flap eversion difficult so use of new technique: Vestibular shift flap design
 - Incision towards buccal, allowing palatal flap to extend 4mm coronal to bone graft prior to wound closure
 - Soft tissue expanders: increase soft tissue volume before grafting
 - Improved microcirculation/rapid osseointegration
- Staged approach preferable (due to occurrence of graft/membrane exposure/postop infections)

Digital Tools

- Printed models from CBCT, surgical/prosthetic planning software
 - Printed models can be used to trim titanium mesh prior to procedure, pre-shape bone block graft/plan fixation screws

Tissue engineering/Cell therapy

- Growth factors (BMP, PDGF, TGFb) used in GBR
- Cell therapy: use of transplanted cells to promote and direct wound healing
- Bone allograft impregnated with bone marrow present as predictable/effective treatment for deficient alveolar ridges
- Evidence for use of mesenchymal stem cells in adipose tissue
- 3D printing of scaffold used; however, unpredictable due to lack / fast degradation
- 3D bioprinting of hard / soft tissues, cartilage, skin
 - Print customized synthetic bone enriched with GF/stem cells

Complications, Sequelae, and Morbidity in Vertical Augmentation

- Short-term complications
 - Flap dehiscence/infection from 1 week to 6 months after surgery
 - Most complications of bone blocks with use of allograft (wound infection, incomplete block integration/mobility, block exposure)
- Complications with nonresorbable membranes (Fontana)
 - Class 1: small membrane exposure ($\leq 3\text{mm}$) without purulent exudate
 - Maintain membrane with plaque control/local antiseptics
 - Class 2: large membrane exposure ($> 3\text{mm}$) without purulent exudate
 - Class 3: membrane exposure with purulent exudate

- Class 4: abscess formation without membrane exposure
 - Class 2-4: immediate membrane removal, and curettage of infected bone particles in class 3 and 4
- Postoperative paresthesia of mental nerve reported in 12-27% of mandibular vertical ridge augmentation
- Blunt dissection to avoid damage to anatomic structures and allow for flap passivation
 - Extensive passivation/coronal advancement results in preop edema/hematoma (peaks at 48-72 hours)
 - Use corticosteroids
- Harvesting of bone blocks:
 - External oblique: minor alveolar nerve injuries
 - Mandibular symphysis: altered sensitivity of lower incisors and paresthesia of the mental region

Factors influencing outcomes of vertical ridge augmentation

- Patient related factors:
 - Smoking: increase osteoblasts by inhibiting osteoclast apoptosis
 - Restrict smoking for at least 3 months before vertical ridge augmentation
 - Diabetes
- Site specific factors:
 - Bone gain in maxilla significantly greater in posterior
 - Bone gain in mandible significantly greater in anterior
 - Optimal results in presence of concave defect neighbored by adjacent bony peaks

Long-term outcomes

- Marginal bone level changes around implants in vertical augmented areas similar to those placed in native bone
- Minimize bone remodeling in vertically augmented areas by placed second protecting layer of bone grafting at time of implant placement
 - Xenograft/autogenous with membrane
- Soft tissue grafting to increase keratinized tissue
- Non-submerged implants reported to having SS greater bone loss

Topic: Augmentation- Titanium Mesh

Authors: Misch CM, Basma H, Misch-Haring MA, Wang HL.

Title: An Updated Decision Tree for Vertical Bone Augmentation.

Source: Int J Periodontics Restorative Dent. 2021 Jan-Feb;41(1):11-21

DOI: 10.11607/prd.4996.

Type: Review

Reviewer: Trisha Nguyen-Luu

Keywords: vertical bone augmentation, titanium mesh, regeneration, bone, periodontal

Purpose: To review the decision making process for vertical ridge augmentation

Discussion:

- Vertical bone augmentation is more biologically + technically challenging b/c you are grafting outside the osseous contour

Techniques for Vertical Bone Augmentation:

- 1) Guided Bone Regeneration:
 - Barrier membrane to occlude soft tissue cells + allow slower growing bone cells to repopulate the defect + regenerate bone
 - Resorbable collagen membrane can be used for small vertical bone gains
 - Cross linking collagen prolongs degradation time, improve barrier function + results in greater vertical gains vs non-cross linked
 - Graft material + Dense polytetrafluoroethylene (d-PTFE) / Ti -reinforced – PTFE + tenting screws, tacks or screws can improve space maintenance
 - 6 months healing time
- 2) Titanium Mesh
 - Metal matrix acts as a form-stable scaffold + particulate bone graft
 - Mesh lattice allows passage of nutrients, cells + vascular in growth
 - Adv of using exogenous chemotactic growth factors

- Can customize with CAD/CAM
- Secured to ridge with screws
- 3) Block Grafts
 - Autogenous block grafts: mandibular symphysis or ramus – mainly cortical bone
 - o Iliac crest: corticocancellous bone
 - o 4 months healing time
 - Allograft, xenograft, alloplast block: lack regenerative capacity
- 4) Interpositional graft
 - Prepare osteotomies in the ridge to completely separate an osteoperiosteal segment attached to a soft tissue pedicle
 - Soft tissue pedicle can limit the vertical movement of bone segment
 - Bone segment is elevated away from the basal bone + secured with a plate
 - Space btw basal bone + bone segment is highly osteoconductive
 - May be filled with autogenous bone or bone substitute in block or particulate forms
 - Does not correct horizontal ridge + transverse deficiency
 - Healing of 4 months
- 5) Distraction osteogenesis:
 - Distraction device transports the osseous segment in a gradual manner (1 mm /day) + is attached to the bone
 - Allow bone regeneration to occur btw separated bone segment within 6- 10 weeks
 - Simultaneous lengthening of surrounding soft tissues so vertical movement of bone is not limited by mucosal attachment
- 6) Orthodontic Extrusion:
 - Non-surgical tx to gain additional vertical bone height + favorable gingival profile
 - Vertical increase of interproximal bone can improve ID papilla to enhance gingival esthetics
 - Hopeless teeth erupted 1 -2 mm/ month + retained in the desired position for 2 -3 months
 - EXT tooth for implant placement

Decision Tree:

- Based on amount of extraosseous VBA needed for implant placement
- Categories for VBA are guidelines based on bone gains from published studies
 - o Green , yellow, red reflect increasing difficulty in achieving predictable + complication free outcomes with greater bone gain
- Low VBA (< 5 mm):
 - o GBR with collagen membrane- up to ~ 3 mm bone gain
 - o titanium mesh: up to ~ 5 mm bone gain B
 - § * bone substitutes with titanium mesh may not result in vertical bone fill
 - § **Need at least 50% particulate autograft is needed for vertical gains > 3 mm with GBR or titanium mesh**
 - § Allograft mixed with BMP-2 is a good alternative to autogenous bone for titanium mesh but expensive
 - o block grafts, Interpositional grafts, orthodontic extractions
- Medium (5-8 mm)
 - o GBR : titanium reinforced d-PTFE with at least 50% particulate autogenous bone mixed with bone substitutes
 - o Titanium mesh: particulate autograft alone or combined with bone substitute 1:1 ratio
 - o Block grafts (ramus, symphysis): ~ 5 mm bone gain
 - § > 5 mm bone gain may require extraoral donor sites (calvarium or iliac crest)
 - o Interpositional graft: up to ~ 8 mm
 - § Atrophic edentulous maxilla can be treated with a le fort 1 osteotomy + corticocancellous Interpositional graft from iliac crest
 - o Distraction osteogenesis
- High (>8 mm)
 - o Corticocancellous Block grafts: Harvested from iliac crest for onlay augmentation
 - § Option to stack cortical block graft from calvarium for greater bone height
 - o GBR: ti- reinforced d-PTFE membrane + particulate autografts mixed with DBBM 75:25 ratio for defects < 4 teeth

- o Ti- mesh: particulate bone from iliac crest or tibia
§ rhBMP-2 with mineralized bone allograft
- o Interpositional graft:
§ severe atrophic edentulous maxilla with le fort 1 osteotomy
- o Distraction osteogenesis: large vertical gain
§ May be better than interpositional graft b/c it overcomes the limitation of vertical movement from soft tissue pedicle

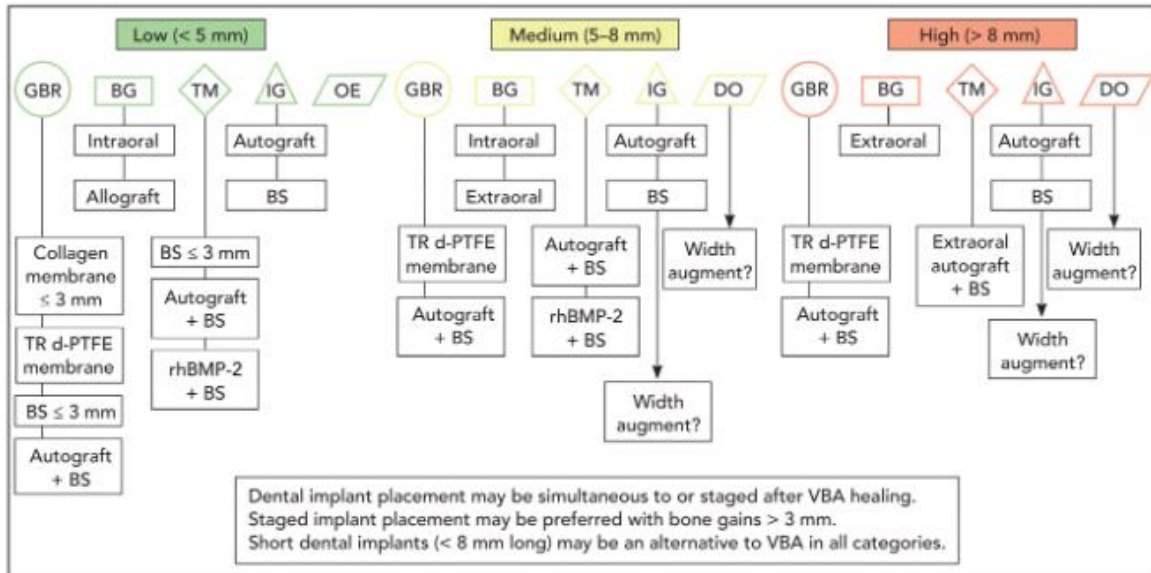


Fig 1 Decision tree for extraosseous vertical bone augmentation (VBA) of the maxilla and mandible. BS = bone substitute (allograft, xenograft, alloplast).

Conclusion:

- Choice for augmentation technique depends on degree of bone loss, size + morphology of osseous defect, location of the mouth, design of prosthesis, clinician or patient preference
- Implants may be placed simultaneously or staged
- Simultaneous implant placement with VBA may shorten overall tx time
 - o Increased risk of post-op incision dehiscence or graft resorption that may compromise bone formation around neck of implant
- Delayed implant placement after site development if > 3 mm of bone gain required
- GBR advantage of being able to perform 3D augmentation
- Bone blocks have advantage of shorter healing + denser bone quality
 - o Complications related to graft harvest morbidity + vary depending on site
 - o Mand ramus has low incidence of complications with nerve impairment
 - o Mandibular symphysis provides more bone volume but greater post-op pain + sensory nerve injury
 - o Calvarium has risk of intercranial injury
 - o Iliac crest has the greatest source of bone but highest morbidity, acute pain, transient sensory deficit, temporary gait disturbance
- Ti-mesh + rhBMP2 avoids bone harvest but sig. More expensive + post-op edema
- Interpositional graft + Distraction osteogenesis decrease morbidity from bone harvest + lower risk of wound dehiscence + implant is placed in native bone
- Distraction osteogenesis has high incidence of complications, issue with vector control + premature consolidation of bony segments, device instability, mandibular fracture, pt compliance + most cases require secondary horizontal augmentation for dental implant placement
 - o High degree of complications in the posterior mandible (jaw fracture) + posterior maxilla (sinus)
 - o Better suited for anterior maxilla + mand
- Partially edentulous anterior + posterior maxilla + mand: GBR, Ti-mesh, block graft, interpositional graft

- Ortho extrusion is usually for anterior maxilla
- MC complication is wound dehiscence- may be related to the amount of augmentation, experience, smoking + soft tissue quality
 - o Early wound dehiscence (prior to revascularization): exposes underlying graft material making it susceptible to displacement, contamination + infection
- Alternative to VBA: less complications, lower cost, shorter treatment time
 - o short dental implants < 8 mm
 - o Tilted implants in the anterior to the sinus or mental foramen
 - o Prosthetic restoration with cantilevered pontics
 - o Zygomatic implants as an alternative to le fort I or interpositional graft or iliac bone block

Augmentation - Titanium Mesh

Topic: vertical ridge augmentation- Ti mesh

Authors: Pieri F, Corinaldesi G, Fini M, Aldini NN, Giardino R, Marchetti C

Title: Alveolar ridge augmentation with titanium mesh and a combination of autogenous bone and anorganic bovine bone: A 2-year prospective study.

Source: J Periodontol 2008; 79:2039–2103

DOI: 10.1902/jop.2008.080061

Type: prospective

Reviewer: Erin Schwoegl

Keywords: Biomaterials; bone grafts; bone regeneration; clinical trials

Purpose: to evaluate Ds placed in sites augmented w a 70:30 mix of autogenous and anorganic bovine bone (BBM*) and a micro-mesh

Materials and Methods:

- Included 16 pts w at least 1 atrophic edentulous site (<9 mm height and 5.5mm in width)
- Pts had insufficient ridges to place DIs in correct prosthetic position

Surgery:

- Included mid-crestal incisions, cortical perforations, periosteal incisions, and primary closure
- Donor harvested from ramus, particulated, and mixed with BBM in a 70:30 mixture
- Ti mesh was fixed w at least 3 micro screws
- Pts seen 1, 3, and 6mo postop
- Site reentered after 8-9mo and DIs placed
- Pts recalled 6 months, 1 and 2 years after loading

Results:

- 16 pts, 19 sites, and 44 DIs completed study and 2 years of follow-ups
- 100% survival at 2 years
- 1/19 meshes (5.3%) exposed after 2mo and was removed
- CT scans found avg vertical augmentation of 1.24- 3.71mm and mean horizontal of 0.59- 4.16mm
- Avg bone resorption of 0.32-1.37mm; 3 DIs w >2 mm,
- 41/44 DIs successful; 93.1%

Conclusion:

- Dis can be successful in sites augmented with a 70:30 mix of autogenous and BBM and Ti mesh
- Peri-implant tissue was healthy and MBR values were satisfactory.
- althy and MBR values were satisfactory.

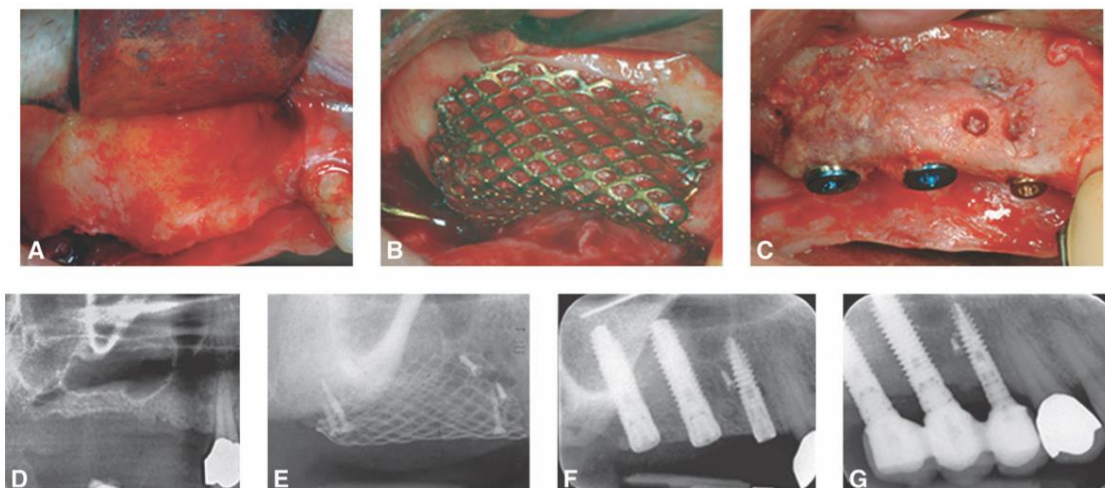


Figure 1.

A) Full-thickness labio-palatal flaps are elevated to expose the residual maxillary ridge (patient 3, Table 1). The alveolar bone is inadequate in the horizontal and vertical dimensions for the placement of implants. **B)** Titanium mesh is placed over the graft material and stabilized with titanium screws. A contemporaneous sinus floor elevation is performed. **C)** Three implants were placed in the reconstructed area. A bone specimen was taken for histomorphometric evaluation. **D)** Preoperative panoramic radiograph shows atrophic edentulous ridge in the posterior region of the right maxilla. **E)** Postoperative periapical radiograph demonstrates bone graft and titanium mesh in position. **F)** Periapical radiograph taken using a long-cone parallel technique at the time of mesh removal shows implants in the second premolar to second molar locations. A remaining titanium microcrew can be seen at the distal aspect of the first implant. **G)** Periapical radiograph after 2 years of prosthetic loading. Some crestal bone remodeling is visible around all three implants.

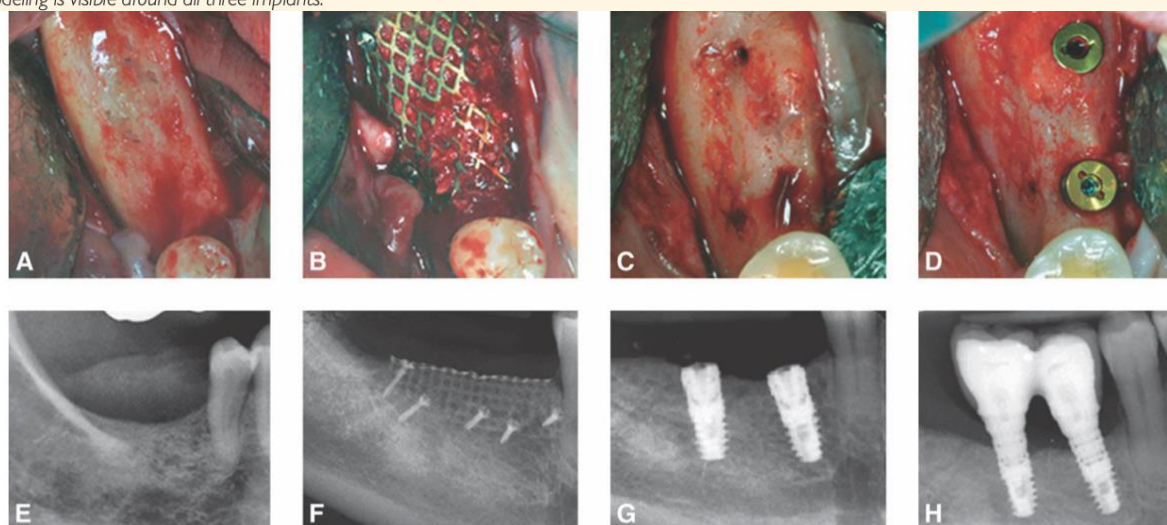


Figure 2.

A) After full-thickness flap elevation, severe horizontal and vertical bone resorption is evident in the right posterior mandible (patient 13, Table 1). **B)** A 70:30 combination of autogenous mandibular bone and anorganic bovine bone is packed into the defect and covered with a titanium mesh. **C)** During the reentry procedure, newly regenerated bone was seen after mesh removal. **D)** The new alveolar ridge allows the placement of two implants completely surrounded by bone. **E)** Preoperative panoramic radiograph demonstrates a vertical bone defect in the molar region of the right mandible. **F)** Periapical radiograph shows bone graft and titanium mesh in position immediately after surgery. **G)** Periapical radiograph taken at implant placement. **H)** Two-year radiograph demonstrates stable bone levels for both implants.

Topic: Ti Mesh

Authors: Levine RA, Lai PC, Manji A, Bruce J

Title: Implant Site Development Using Titanium Mesh in the Maxilla: A Retrospective Study of 58 Mesh Procedures in 48 Patients

Source: Int J Periodontics Restorative Dent. 2022 Jan-Feb;42(1):43-51.

DOI: 10.11607/prd.5530.

Type: Retrospective Study

Reviewer: Brook Thibodeaux

Keywords: n/a

Purpose: To discuss the clinical results of bone augmentation using a Ti-mesh scaffold in the maxillae of 3 representative cases.

Material and methods:

- Retrospective study
- 48 patients, 7 different biomaterial combinations with Ti-mesh, 58 mesh sites, 91 DIs
- Sx protocol: tooth extraction w/ GBR using Ti- mesh.
 - o Tooth extracted, wounds healed spontaneously for 2-3mo for complete ST closure. FTF raised w/ vertical incision at D end of flap for visualization/access. Intramarrow penetrations on B surface of ridge. Ti-mesh secured to the B w/ stabilizing screws which created a B wall to pack bone graft. Ti mesh trimmed to keep 1.5mm from adj teeth. Additional tenting screws used to support mesh when needed. Graft placed. Surgical site sutures to obtain tension free primary closure.
- Post Ops: 3wk suture removal, plaque control reinforced at 4,8, 12wk
- Early exposure: </-6wks, late exposure: >6wks
- F/u CBCT taken at 5-6mo post op, DI placement 7-9mo post op

Results:

- Mean gain horizontally: 4.7mm
- Mean gain vertically: 2.8mm
- Mesh exposures: after 13 procedures, 22% of the time
 - o No exposures required early removal
 - o Late exposures: 62.5%, early exposures= 37.5%
 - o Thin phenotype related to 3 exposures, medium related to 7 exposures, thick to 3 exposures
 - o Older and middle aged adults had SS higher risk of mesh exposure vs young adults
 - o Mean horizontal gain was slightly less than unexposed sites (4.4mm vs 4.8mm)- NSSD
 - o SS lower odds of needing additional contour augmentation associated w/ use of complete denture as provisional restoration
- Most common complication post operatively: mesh exposure
 - o Early exposure more detrimental to bone gain compared to late exposure.

Conclusions: Ti mesh in combo with a variety of biomaterials is an effective technique for development of the maxilla for DIs. In this study, all cases had sufficient bone gain for DI placement. Older adults have higher chance of membrane exposure versus younger, especially in the anterior region.

Topic: titanium mesh exposure

Authors: Lizio G, Corinaldesi G, Marchetti C.

Title: Alveolar ridge reconstruction with titanium mesh: a three-dimensional evaluation of factors affecting bone augmentation

Source: Int J Oral Maxillofac Implants. 2014 Nov-Dec;29(6):1354-63.

DOI: 10.11607/jomi.3417

Reviewer: Amber Kreko

Type: clinical trial

Keywords: alveolar ridge 3D reconstruction, titanium mesh exposure

Purpose: To evaluate the 3D reconstruction of atrophic alveolar ridges using titanium mesh (Ti-mesh) and its correlation with the extent and timing of mesh exposure and amount of reconstruction planned

Material and methods:

- 12 patients with 15 alveolar defects treated with Ti-mesh technique and 70/30 autogenous/ABB particulate bone (Bio-Oss) were reviewed retrospectively. Implant placement was done 8-9 months later.
- 11 maxilla and 4 mandibles were treated. 5 patients had autogenous harvested from iliac crest

- and other 11 from mandibular ramus.
- Vertical augmentation of 5-7mm and horizontal augmentation of 4-5mm were planned. Meshes were loosely attached with one or two fixation mini-screw maintaining a distance of 2-3mm between edge of mesh and periodontal structure of the adjacent teeth. Graft was placed underneath and ti-mesh secured using 2-3 mini-screws on buccal side
- CBCTs were used to calculate the reconstructed bone volume (RBV) and planned bone volume (PBV) to determine the bone volume lacking (LBV). $PBV - RBV = LBV$

Results:

- 12/15 augmented sites had exposure of mesh during healing. 7 sites in first 4-6 weeks with no superimposed infection. 5 sites after 4-6 weeks
- Mean time of mesh exposure was 2.17 months
- Mean area of exposure was 0.73cm². At reopening, layer of CT called "pseudo-periosteum" involving Ti-mesh was observed
- Mean LBV was 0.45cm³ and was 30.2% of mean PBV (1.49). Mean RBC was 1.04cm³.
- LBV was significantly positively correlated with area of mesh exposed with 16.3% LBV for every cm² of mesh exposed.

Conclusions: This investigation of the effectiveness of Ti-mesh technique found there was 30.2% less bone than planned preoperatively. Reconstructed bone volume was significantly influenced by area of mesh exposure.

Topic: titanium mesh exposure

Authors: Al-Ardah A. et al.

Title: Managing titanium mesh exposure with the partial removal of the exposed site: A case series study.

Source: J Oral Implantol. 2017;43(6):482-490

DOI:10.1563/aaid-joi-D-17-00169

Reviewer: Tam Vu

Type: Case study

Keywords: titanium mesh exposure, treatment, ridge augmentation, bone grafting

Purpose: to introduce a new treatment approach for exposed titanium mesh (TiMe)

- removal of TiMe that is exposed and leaving remainder until bone graft heals and matures, allow soft tissue migration over exposed graft material without disrupting bone healing.

Background:

- All cases had at least 2 failed alveolar ridge augmentation previously
- CBCT was used to analyze ridge augmentation

Case 1:

- 50 yo female – ridge aug at #9 and 10
- Ridge augmentation with 50/50 cortical and allograft, TiMe, and covered with resorbable bilayered collagen membrane)
- 4x4 mm exposure of TiMe at week 4 on palatal side
- Portion of exposed TiMe removed using carbide burs and scissors (12 weeks after initial grafting, and 8 weeks after exposure noted)
- Remainder of mesh left submerged until 6.5 mo after grafting
- Mesh removed and graft was well integrated, minimal granulation
- 4.1 mm horizontal and 4.5 mm of vertical ridge augmentation
- Bone volume obtained was adequate for implant placement

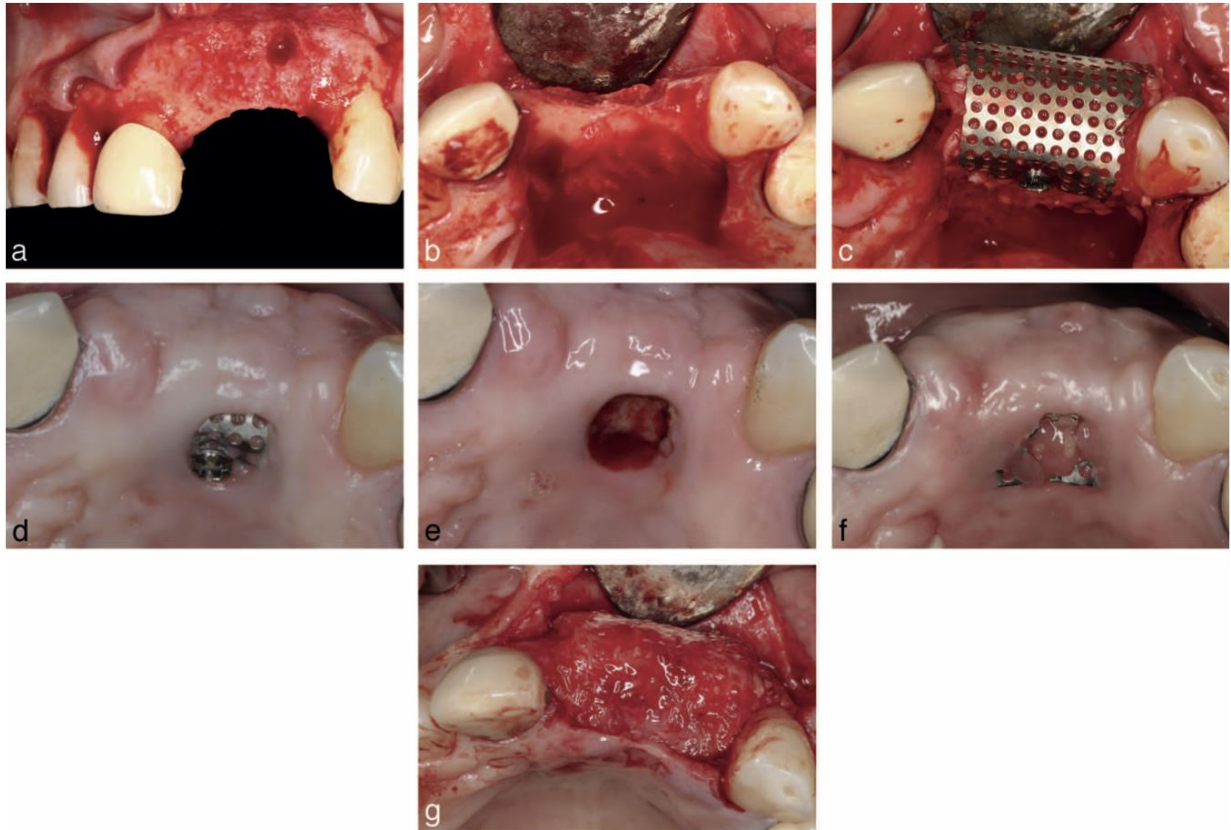


FIGURE 1. Showing case 1. (a) Facial view of defect at time of surgery. (b) Occlusal view of defective alveolar ridge following full-thickness flap reflection. (c) Occlusal view of titanium mesh (TiMe) in position following fixation. (d) Occlusal view of palatal TiMe exposure. (e) Occlusal view at time of partial removal of exposed TiMe. (f) Occlusal view showing healing after partial removal of exposed TiMe. (g) Occlusal view of regenerated alveolar ridge at time of implant placement.

Case 2:

- 47 yo male ridge aug at #8
- TiMe was covered with platelet-rich fibrin (PRF) instead of collagen membrane
- 6x10 mm exposure at week 1 on crest extending to labial aspect
- Exposure removed at week 10 and remaining portion left submerged until 6.5 mo
- During surgical removal of TiMe, graft was well integrated with minimal granulation
- 7.8 mm horizontal and 4.6 mm vertical ridge augmentation
 - Sufficient for implant placement

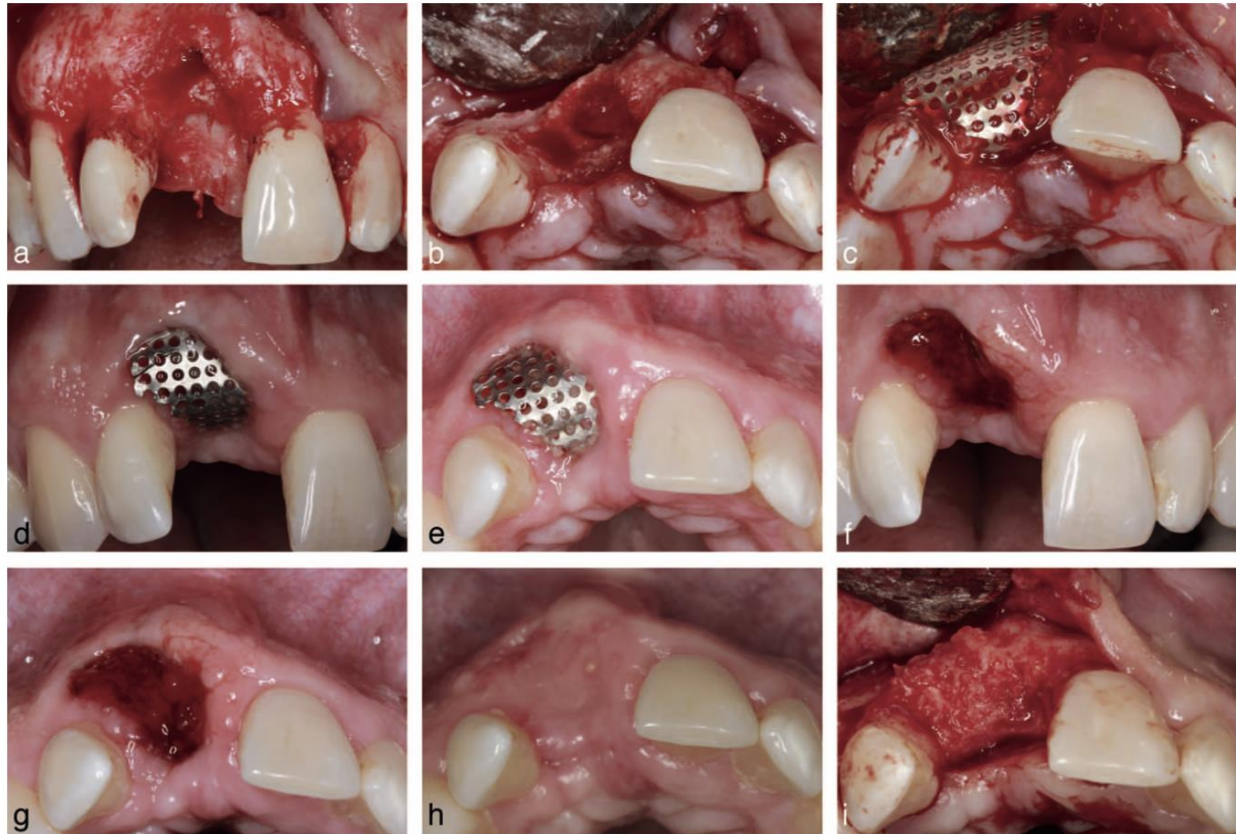


FIGURE 2. Showing case 2. (a) Facial view of defect at time of surgery. (b) Occlusal view of defective alveolar ridge following full-thickness flap reflection. (c) Occlusal view of titanium mesh (TiMe) in position following fixation. (d) Facial view of TiMe exposure at the crest of the ridge with facial extension. (e) Occlusal view of TiMe exposure. (f) Facial view at time of partial removal of exposed TiMe. (g) Occlusal view at time of partial removal of exposed TiMe. (h) Occlusal view showing healing after partial removal of exposed TiMe. (i) Occlusal view of regenerated alveolar ridge at time of implant placement.

Case 3:

- 44 yo female for grafting at #9-11
- Similar to case 1, except fresh frozen allograft used instead of the resorbable collagen membrane
- 11x4 mm mesh exposure located along the crest at week 6, removed 4 weeks later
- Remaining TiMe left submerged and surgically removed at 6.5 mo after initial grafting
- At removal, graft was well integrated and minimal granulation tissue observed
- 4.6 mm horizontal, 7.0 mm vertical ridge augmentation

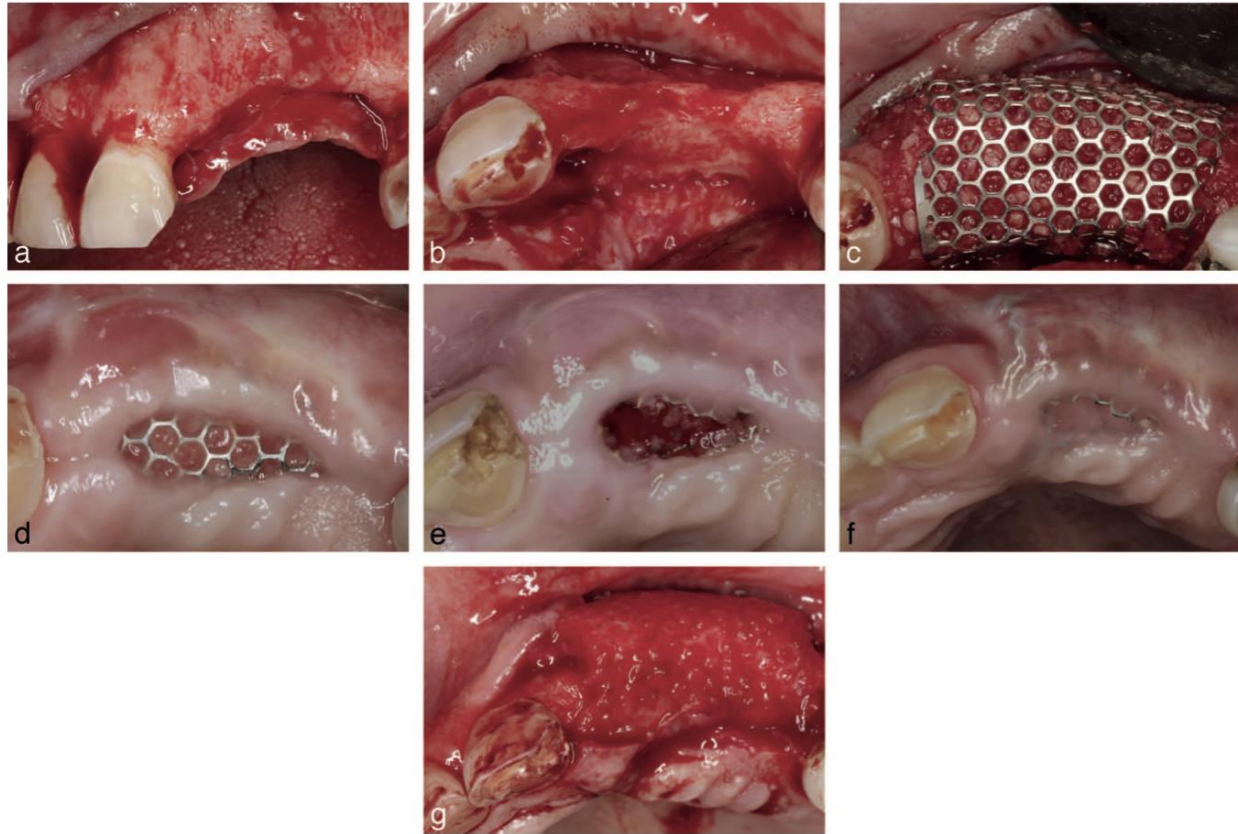


FIGURE 3. Showing case 3. (a) Facial view of defect at time of surgery. (b) Occlusal view of defective alveolar ridge following full-thickness flap reflection. (c) Occlusal view of TiMe in position following fixation. (d) Occlusal view of TiMe exposure at crest of ridge. (e) Occlusal view at time of partial removal of exposed TiMe. (f) Occlusal view showing healing after partial removal of exposed TiMe. (g) Occlusal view of regenerated alveolar ridge at time of implant placement.

Case 4:

- 27 yo male ridge aug at #9
- Procedure same as case 1, in addition, PRF membrane was used on top of resorbable collagen membrane
- 5X3 mm TiMe exposure at week 3 on the palatal side, removed 5th week after initial grafting
- Remaining portion left submerged until 6 mo
- At removal, graft well integrated with minimal granulation tissue
- 5.4 mm horizontal, 3.1 mm vertical ridge aug achieved
 - Adequate for implant placement

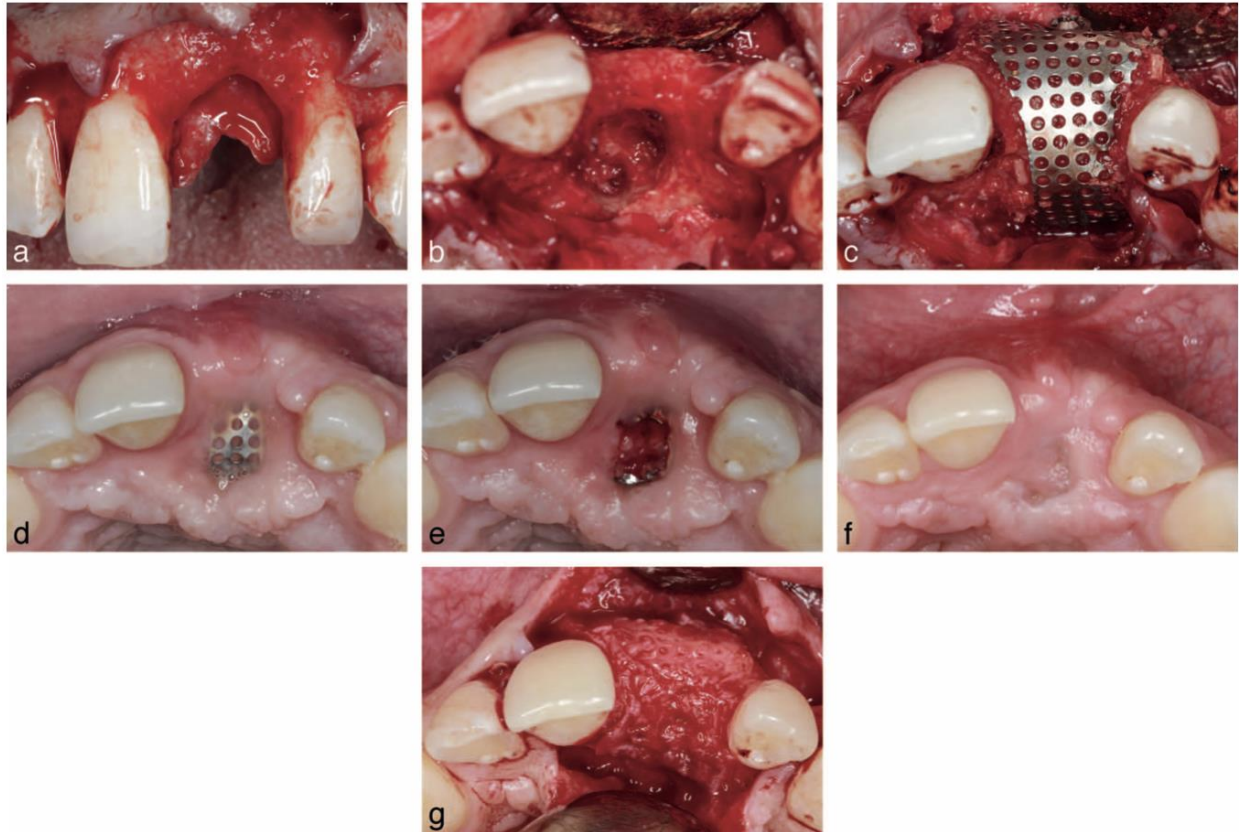


FIGURE 4. Showing case 4. (a) Facial view of defect at time of surgery. (b) Occlusal view of defective alveolar ridge following full-thickness flap reflection. (c) Occlusal view of titanium mesh (TiMe) in position following fixation. (d) Occlusal view of TiMe palatal exposure. (e) Occlusal view at time of partial removal of exposed TiMe. (f) Occlusal view showing healing after partial removal of exposed TiMe. (g) Occlusal view of regenerated alveolar ridge at time of implant placement.

Discussion:

- Case series reported on average 5.5 mm horizontal and 4.8 mm vertical alveolar ridge augmentation
- Rationale behind removing exposed portion of TiMe was to lessen micromovement of the mesh and decreasing amount of granulation tissue formation.
 - Granulation tissue formation from micromovement of TiMe has not been validated
- Removing exposed portions of mesh and leaving remaining portions submerged did not compromise final clinical outcome

Conclusion:

- Removal of exposed TiMe did not negatively affect the integration of grafted bone or bone volume for implant placement. Still needs more research.

Topic: Vertical bone

Authors: Cucchi A et al.

Title: Evaluation of complication rates and vertical bone gain after guided bone regeneration with non-resorbable membranes versus titanium meshes and resorbable membranes. A randomized clinical trial.

Source: Clin Implant Dent Relat Res. 2017 Oct;19(5):821-832

DOI: 10.1111/cid.12520

Reviewer: Daeoo Lee

Type: RCT

Keywords: vertical bone, GBR

Purpose: To evaluate complication rates and vertical bone gain (VBG) after GBR with dense PTFE titanium-reinforced membranes versus with titanium mesh covered with cross-linked collagen membranes.

Material and methods:

- No info on the dPTFE and Ti-mesh
- N=40, with partial edentulism or vertical peri-implant bone defect(≥ 2 mm), @posterior regions of the mandible
- Clinical procedures
 - Prophylactic antibiotic
 - Midcrestal + 45° buccal incision on distal + vertical incision buccally/lingually on the mesial side
 - One or more tapered implants with double-variable thread designs and a double-acid-etched (DAE) surface (BT SAFE; Biotec srl, Vicenza, Italy)
 - Mandible perforated
 - 0.5-1.0g of autogenous bone harvest from external oblique ridge
 - Autogenous bone + allograft (EnCore, Osteogenics Biomedical, Lubbock, Texas), 50/50.
 - (Test vs. control) dPTFE or Ti mesh + titanium mini screw + collagen membrane over
 - Sutured flap
 - Antibiotics and post-op instruction
 - (T1) 9 mo post-op, opened up flap to remove barrier and mini-screws. Measurements of bone gain.
 - CT graft performed.
 - (T2) 2-3 mo functional loading.
 - Data Collection: Implant stability, surgical and healing complications, peri-Implant bone defects and vertical bone gain
 - Data Management and statistical analysis

Results:

- Population
 - Started: N=40 (ASA I and II), 108 implants
 - Included study: 39 patients with 106 implants
- Primary Implant stability
 - Group A:
 - T0: torque 80 Ncm, RFA 87
 - T1: reverse torque 25Ncm used, RFA 71
 - Group B
 - T0: torque 79 Ncm, RFA 84.5
 - T1: Reverse torque 25Ncm, RFA 66.5
- Surgical complications
 - 4 neurological (paresthesia) complication
 - Group A: 1/20
 - Group B: 3/19
- Healing complications
 - Group A: 3/20, membrane exposure w/ or w/o purulent exudate and abscess w/o exposure
 - Group B: 4/19, membrane exposure w/ or w/o purulent exudate and abscess w/o exposure
- Peri-Implant bone defect and vertical bone gain
 - Group A: Vertical bone gain (VBG): 4.2mm
 - Group B: VBG: 4.1mm

Conclusions: d-PTFE membranes and titanium mesh plus collagen membranes produced similar results in terms of healing complication types and rates. In contrast, d-PTFE membranes showed a lower rate of surgical complications. In both groups, similar vertical bone gain (VBG) and bone formation were achieved.

Topic: CAM/CAM TiMesh

Authors: Chiapasco M., Casentini P., Tommasato G., Dellavia C., Del Fabbro M.

Title: Customized CAD/CAM titanium meshes for the guided bone regeneration of severe alveolar ridge defects: Preliminary results of a retrospective clinical study in humans

Source: Clin Oral Impl Res. 2021;32:498–510.

DOI: 10.1111/clr.13720

Reviewer: Cyrus J Mansouri

Type: Retrospective study

Keywords: alveolar bone defects, autogenous bone, CAD-CAM, custom-made, dental implants, guided bone regeneration, implant-supported prosthesis, titanium mesh

Purpose:

To present the results of guided bone regeneration (GBR) of atrophic edentulous ridges with customized CAD/CAM titanium meshes.

Material and methods:

41 patients were recruited with 53 atrophic sites

- GBR was performed with titanium meshes filled with autogenous bone chips and bovine bone mineral (BBM).
- Meshes were removed and 106 implants placed after a mean of 3.5 months.
- Outcomes of vertical and horizontal bone augmentation changes, biological complications and implant survival were assessed.

Results:

11 sites experienced mesh exposure:

- 8 experienced uneventful integration of the graft
- 3 experienced partial bone loss.

Bone gain:

- Vertical bone gain was 4.78 ± 1.88 mm
- Horizontal bone gain was 6.35 ± 2.10 mm

Upon implant placement, mean changes of initial bone gain were -0.39 ± 0.64 mm and -0.49 ± 0.83 mm, in the vertical and horizontal dimensions, respectively.

- Reduction of bone volume was significantly higher in the exposed sites.

The survival rate of implants was 100%.

Conclusion:

Customized titanium meshes can represent a reliable tool for GBR of severely atrophic sites, with simplification of the surgical phases.

Topic: Titanium Mesh

Author: Cucchi A, Vignudelli E, Franceschi D, Randellini E, Lizio G, Fiorino A, Corinaldesi G.

Title: Vertical and horizontal ridge augmentation using customized CAD/CAM titanium mesh with versus without resorbable membranes. A randomized clinical trial.

Source: Clin Oral Implants Res. 2021 Dec;32(12):1411-1424.

DOI: 10.1111/clr.13841.

Type: RCT

Reviewer: Veronica Xia

Keywords: vertical bone augmentation, horizontal ridge augmentation, titanium mesh, membrane

Purpose:

- Evaluate role of resorbable membranes over customized CAD/CAM titanium mesh on:
 - Surgical/technical and healing complications
 - Bone density
 - Pseudo-periosteum between the mesh and newly formed bone
 - Volumetric bone gain/regeneration rates

Materials and Methods:

- 30 patients enrolled
 - 15 patients in group A (Mesh-): custom made titanium mesh alone
 - 15 patients in group B (Mesh+): custom made titanium mesh and resorbable membrane
- Surgery:
 - Reconstructive surgery
 - Collagen membrane used: Cytoplast over titanium mesh
 - Mesh removal/implant placement
 - At 6 months, screws and titanium meshes removed
 - Bone tissue taken with core drill for histological / micro-CT analysis
 - Thickness of pseudo-periosteum (dense CT with low cellularity and no mineralization under titanium mesh / PTFE membranes) measured with UNC-15 periodontal probe
 - Density of new bone measured
 - High, medium, low density (resistance to 30gm probing force penetration)
 - Implant reopening / soft tissue management
 - At 3 months after implant placement, osteointegration checked by applying counter torque of 25Ncm
 - Soft tissue managed to improve quality/quantity of peri-implant mucosa
- Clinical and healing data recorded
- Bone volume and regeneration rate recorded by comparing CBCT before and after

Results:

- Defects
 - Anterior: 7
 - Posterior 23
- No failures for primary closure observed
 - 4 patients experienced paresthesia
 - 3 patients experienced a technical complication
 - Two partial mesh fractures and one partial mesh misfitting
- NSSD in surgical/technical complication rates:
 - Mesh-: 13.3%
 - Mesh+: 26.7%
- 7 patients experienced healing complications (ie exposure with/without infection)
 - Mesh removed
 - NSSD between Mesh+/-
- NSSD in pseudo-periosteum thickness, bone volume, regeneration rate between Mesh+/-

Conclusion:

- Custom-made mesh alone is not inferior to custom-made mesh with membrane
 - NSSD, but some variables showed better results in Mesh+ group (membrane may have positive role regarding healing complication rates and regeneration rates)