Extraction – Ridge preservation

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Extraction – Ridge preservation

Topic: Extraction Ridge Preservation
Authors: Elian N, Cho SC, Froum S, et al.
Title: A simplified socket classification and repair technique

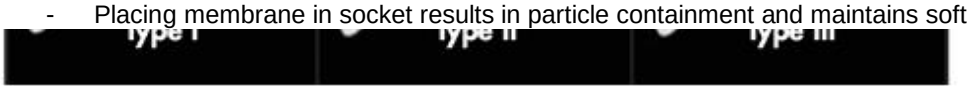
Source: Pract Proced Aesthet Dent. 2007;19(2):99-104.
DOI: -
Type: Review
Reviewer: Trisha Nguyen-Luu
Keywords: Extraction socket, buccal plate, type II socket, noninvasive
Background:Primary factor in determining treatment options in the aesthetic zone is the presence and degree of soft tissue recession and buccal bone plate.

Purpose: To review a extraction socket classification system and socket-repair technique
Discussion:

- Type I: Facial soft tissue and buccal plate of bone are at normal levels in relation to CEJ of the pre-extracted tooth and remain intact post-extraction
    - easiest and most predictable to treat
    - Excellent aesthetic with implants especially with a thick and flat profile
- Type II: Facial soft tissue is present but the buccal plate is partially missing following extraction
    - most difficult to diagnose (mistaken as type I and leads to poor aesthetic results
    - may result in posttreatment soft tissue recession
    - Socket Repair Technique:
        - Atraumatic/ flapless extraction - preserve AG, IP papillae + labial soft tissue
        - Debride socket – Finger should be placed over buccal tissue when curetting the socket to prevent perforation of soft tissue
        - Cut absorbable collagen membrane into a modified v-shape – wide enough to extend laterally past the defect in the buccal wall + cover the opening of the socket after graft placement
        - Narrow part of the membrane is placed INTO the socket
            - Placing membrane on external aspect of buccal wall could compromise its blood supply and increase change of resorption
            - Periosteum is not detached from the remaining buccal plate
            - If you compress the graft, you can push the buccal tissue facially → does not compromise buccal tissue contours
        - Membrane is positioned into the socket lining the buccal tissue
        - Socket is filled with bone graft (small particle, mineralized cancellous FDBA (0.25-1 mm) that has been hydrated for 5 minutes
        - Top of membrane is sutured with 5-0 absorbable sutured to the palatal tissue
- Type III: Facial soft tissue and the buccal plate of bone are markedly reduced after extraction
    - very difficult to treat - require soft tissue augmentation with additional CT and or bone graft with a staged approach
    - Associated with soft tissue recession and loss of buccal plate **before** tooth extraction

Conclusion:

- By not reflecting or coronally advancing the buccal flap there is no change in the MGJ position
- Goal of socket preservation should be to maintain both hard AND soft tissue levels
- Placing membrane in socket results in particle containment and maintains soft tissue morphology



Topic: ridge changes after tooth extraction
Authors: Araujo MG, Lindhe J
Title: Dimensional ridge alterations following tooth extraction. An experimental study in the dog
Source: . J Clin Periodontol 2005:32: 212–218
DOI:
Type: animal (dog) study
Reviewer: Erin Schwoegl

Purpose: to evaluate the changes in alveolar ridge dimension after tooth extraction in dogs

Material and methods:

- Included 12 dogs
- The premolars were sectioned and the distal root was removed
- The extraction sites were covered with gingiva
- Dogs were sacrificed at 1, 2, 4, and 8 weeks post-ext
- Block sections were examined

Results:

- Osteoclastic activity occurred on both buccal and lingual walls which resulted in crestal resorption
    - Horizontal bone loss due to osteoclasts in lacunae of both buccal and lingual walls
- The height of the buccal wall was more pronounced than the lingual aspect
- Resorption occurred in 2 phases
    - Phase 1: bundle bone resorbed and replaced with woven bone
        - Substantial vertical reduction of buccal crest from this phase
    - Phase 2: resorption occurred from outer surfaces of buccal and lingual walls

Conclusions:

- Significant alterations occurred within first 8 weeks
- Occurs with 2 overlapping phases
- Buccal bone lost significantly more than lingual

Topic: Ridge Dimension
Authors: Araujo MG, Lindhe J.
Title: Ridge alterations following tooth extraction with and without flap elevation.
Source: Clin Oral Impl Res 2009:20: 545–549
DOI: 10.1111/j.1600-0501.2008.01703.x
Type: Experimental Study
Reviewer: Brook Thibodeaux
Keywords: bone resorption, extraction, flapless surgery

Purpose: To analyze the effects of tooth extraction on the alveolar ridge 6mo post extraction w/ or w/o flap elevation

Material and methods:

- 5 beagle dogs participated, bilateral mandibular second premolars tested
- Test: Full thickness B/L flaps elevated beyond MGJ, 3-4mm of marginal bone exposed for 15 min. retainment of M root
    - 2nd premolars of each side of the mandible were hemi-sected w/ fissured bur, M root reamed and filled w/ gutta percha, distal root carefully removed w/ elevators, extraction wound on both sides closed via interrupted sutures
- Control: no flaps/incisions created, extraction of full tooth (contralateral side)
- Plaque control via tooth cleaning once every other day
- Healing for 6months, dogs exterminated and jaws removed
- Each experimental site removed (M root/distal socket area) and sectioned into 4- two from M root, 2 from healed socket

Results:

- No complications, uneventful healing with all experimental sites. Mucosal covering edentulous ridge and gingival tissue on adjacent teeth showed health clinically
- Histo Tooth Site
    - Medial mental foramen located in B bone close to the apex of the M root, L bone markedly wider, crest of B bone consistently more apical to L crest
    - Ging margin in both groups consistently more coronal to CEJ and CT free of inflammatory infiltrates.
    - Flapless group: Mesial root B surface- the junctional epithelium was at the CEJ (.07mm

Buccal and 0mm Lingual), coronal portion of buccal bone composed of bundle bone
    - Flapped group: M root B surface- junctional epithelium was apical to CEJ (0.2mm Buccal and 0mm Lingual), coronal portion of buccal bone showed signs of resorption
    - Signed of CT attachment loss on the B surface of the flapped group, no signs of CT attachment loss on the L of either group.
    - Buccal bone to CEJ distance: flapped= 1mm, flapless= 0.7mm; SSD
- Histo Extraction Site
    - Similar features overall for both groups: thick, keratinized mucosa covered socket, CT absent of inflammation w/ dense collagen fiber networks. Socket entrance closed by hard tissue bridge including woven and lamellar bone. Middle/apical portions contained bone marrow/small amounts of lamellar bone
    - Slight reduction in the overall dimensions of the ridge
        - Overall dimensions % decreased vs corresponding tooth site
            - Flapped: 14%
            - Flapless: 17%
        - Coronal portion dimensions % decreased vs corresponding tooth site
            - Flapped: 35%
            - Flapless: 35%
        - Apical portion dimensions % decreased vs corresponding tooth site
            - Flapped: 5%
            - Flapless: 6%
        - Mid portion dimensions % decreased vs corresponding tooth site
            - Flapped Apical portion: 14%
            - Flapless Apical portion: 9%
        - Substantial decrease in the coronal portion regardless of technique, minor decrease in mid/apical portions

Conclusions: Substantial alterations to the ridge can result from extraction. The alveolar process size decreased. Flapped vs Flapless surgical technique did not influence the results.

Topic: socket healing
Authors: Araújo, M., et al.
Title: Alveolar socket healing: what can we learn?
Source: Periodontol 2000. 2015 Jun;68(1):122-34.
DOI: 10.1111/prd.12082
Reviewer: Amber Kreko
Type: review
Keywords: healing, alveolar socket, extraction

Purpose: To describe socket-healing process and to discuss what is to be learned from that healing process that may improve the treatment outcome.

Discussion:
- Alveolar process – bone tissue that surrounds a fully erupted tooth
    - Anatomic considerations – morphologic characteristics are related to size and shape of the tooth, site of tooth eruption, and inclination of the erupted tooth.
    - Histologic considerations – inner portion known as alveolar bone proper or bundle bone and remaining hard structure is alveolar bone. In bundle bone, sharpey's fibers connect PDL to alveolar bone and skeleton. Bundle bone is tooth-dependent.
- Socket healing
    - Dimensional changes – In multiple tooth extraction, alveolar ridge undergoes contraction in vertical and horizontal directions. In single tooth, there's limited vertical reduction but horizontal is substantial (50% reduction), greater at buccal aspect and larger in molar regions. Most dimensional changes occur within first 3 months but may continue for up to 1 year.
    - Histologic changes –
        - Inflammatory phase – blood clot formation and inflammatory cell migration. Blood clot plugs severed vessels and stops bleeding. After 2-3 days, large

number of inflammatory cells migrate to wound to clean the site before new issue can start forming.
        - Proliferative phase – fibroplasia and woven bone formation characterized by intense and rapid tissue formation. Fibroplasia involves rapid deposition of provisional matrix which is penetrated by vessels and bone-forming cells and finger-like projections of woven bone are laid down around the blood vessels.
        - Bone modeling and remodeling phase – bone modeling is change in shape and architecture of the bone, whereas bone remodeling is defined as a change without concomitant change in the shape and architecture of the bone. Replacement of woven bone with lamellar bone or bone marrow in bone remodeling and bone resorption takes place on the socket walls leading to dimensional alteration of alveolar ridge is result of bone remodeling.
    - Stimulating factors – healing responses are regulated by signaling molecules such as platelet derived growth factor, insulin like growth factors, transforming growth factor-beta and fibroblastic growth factors. Fibroblast growth factor 2 presented at higher levels at early time points then returns to lower levels. Vascular endothelial growth factor levels were constant during healing. Platelet derived growth factor A levels increased during the first days of socket healing. Transforming growth factor beta 1 had small elevation at early time points. Increased bone morphogenetic protein 2 was observed when osteoblast precursors accumulated.
- What can be learned
    - Healed socket fills with newly formed bone and ridge contracts. Ridge reduction is larger in molar region and more critical in anterior region because of esthetic demands.
    - Post extraction ridge reduction appears to be related to several factors such as surgical trauma, lack of a functional stimulus on bone walls, lack of bundle bone, and periodontal ligament and genetic information.
    - Grafting sockets with different materials, and the use of mechanical barriers have been proposed to prevent alveolar ridge reduction, secondary to bone modeling.
    - Placement of a biomaterial in an extraction socket may modify modeling and compensate for the buccal bone loss. Grafted site reduction was 3% and non-grafted site was 25%.

Conclusions: Tooth extraction should be performed with understanding that ridge reduction will follow and clinical steps should be considered to compensate for the change when considering future reconstruction or replacement of the extracted tooth.

Topic: Ridge Preservation
Authors: Jung RE, et al.
Title: Alveolar ridge preservation in the esthetic zone
Source: Periodontology 2000, Vol. 77, 2018, 165–175
DOI: 10.1111/prd.12209
Reviewer: Tam Vu
Type: Review
Keywords: ridge augmentation, esthetic zone, hard, soft, tissue grafting, dental implant

Purpose: Review alveolar ridge preservation in the esthetic zone

Anatomy of extraction socket in esthetic zone
- Buccal bone plate in anterior maxilla is <1 mm thick.
    - After extraction, buccal plate may be resorbed mainly in crestal region

Spontaneous healing following extraction
- After ext à ridge has both vertical and horizontal reduction
    - Vertical reduction on buccal side: 11-22% after 6 months
    - Horizontal reduction on buccal: 29-63% after 6-7 months
- Rapid alteration of bone within first 3-6 months, followed by gradual reduction (0.5-1.0% yearly)
- BL: after single tooth ext: up to 50% ridge reduction with bone resorption predom. at buccal

aspect

Immediate implant placement

- Can be performed with or without a flap and with or without bone graft (GBR)
- Without add'l grafting à significantly more bone resorption (~50% of initial bone width in horizontal dimension)
    - In other words, immediate implant placement + GBR = less horizontal bone resorption

Alveolar ridge preservation procedures

- 3 options:
    - Soft tissue grafts
    - Hard tissue graft materials
    - Combination
- Main goals:
    - Eliminate/limit post-extraction ridge alterations
    - Promote soft and hard tissue healing within socket
    - Facilitate of implant placement in ideal position without add'l augmentation
- Based on:
    i. Timepoint chosen and ability to place implant
    ii. Quality and quantity of soft tissue
    iii. Remaining height of buccal plate
    iv. Expected implant survival and success rates

Preservation of soft tissue

- Flapless approach to preserve/gain KT
- Autogenous CTG is best to maintain ridge profile during healing
    - Biomaterials are mainly to maintenance space

Preservation of hard and soft tissue

- Combo of soft and hard tissue preservation for long-term healing
- Socket seal techniques: combine use of biomaterials placed at bony level of soft tissue grafts/substitute at level of soft tissues to seal off extraction socket à minimal changes in horizontal and vertical dimensions

Preservation of hard tissue

- Ridge preservation with bone-substitute and membrane SS less reduction of bone height and width, however, longer healing period

<u>Clinical concept for alveolar ridge preservation procedures</u>
Clinical decision-making process

Table 1. Individual aims, clinical indications and limitations of treatment modalities

Treatment option	Aim	Clinical indications	Limitations
Soft-tissue preservation	Improve the quantity and quality of soft tissues at the time of tooth extraction.	Ankylosed teeth with vertical soft-tissue deficiencies. Teeth with soft-tissue recessions Teeth lacking keratinized tissue	Teeth with acute infections. Large bone defects Technique sensitive in terms of soft-tissue management in sites with extensive soft-tissue defects
Hard- and soft-tissue preservation (socket seal technique)	Regenerate and preserve the hard tissue and the soft tissue at the time of tooth extraction without flap elevation.	Small buccal bone defects (less than 50% of the buccal bone plate missing), with or without soft-tissue defects. As a method for implant placement 4–6 months thereafter Pontics of conventional reconstructions	The socket seal technique does not allow for 100% preservation of the ridge contour and therefore needs, in highly esthetic areas, a further small contour augmentation.
Hard-tissue preservation (guided bone regeneration)	Regenerate and augment the alveolar bone at the time of tooth extraction.	Large buccal bone defects (> 50% of the buccal bone plate missing), scheduled for late (> 6 months) implant placement.	Invasive surgery at the time of tooth extraction without implant placement. Long healing time

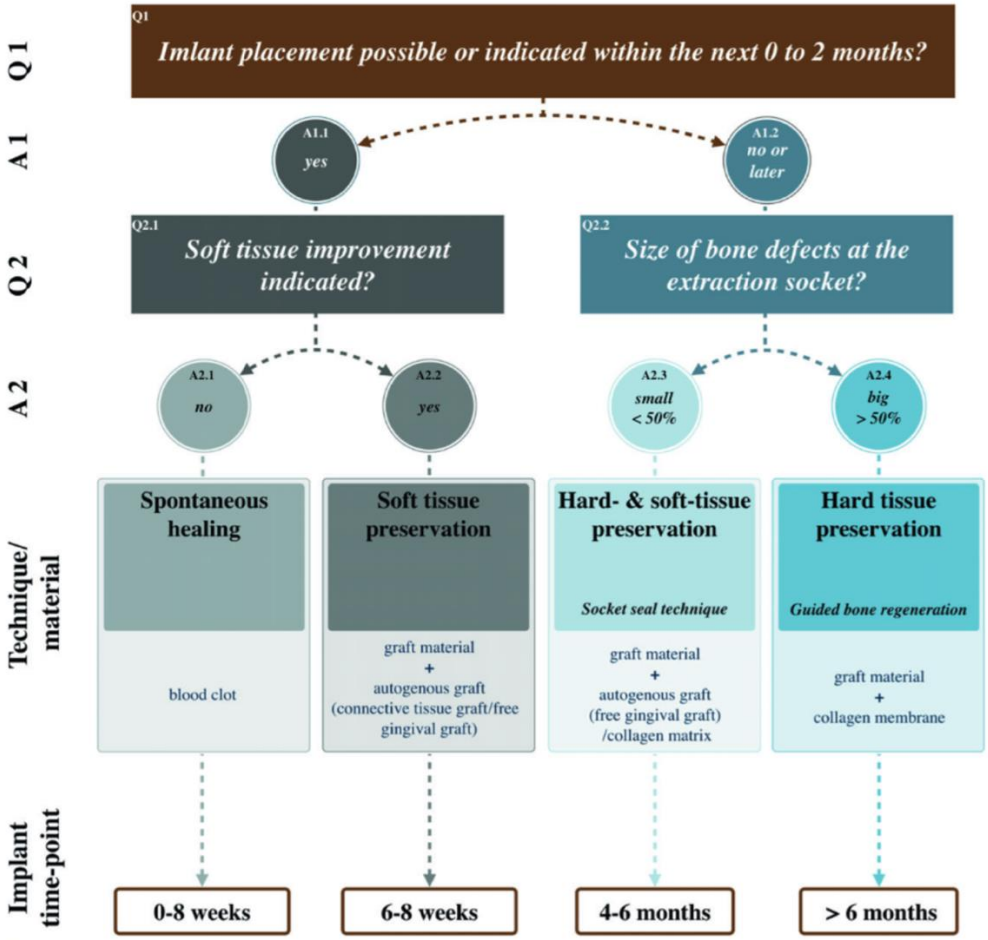


Fig. 1. Clinical decision tree, leading to the different alveolar ridge-preservation procedures. A, Answer; Q, Question.

Clinical concept for soft tissue preservation with autogenous soft tissue graft

- 29 y/o women with ankylosed #8 and vertical soft and hard tissue deficiency
- Atraumatic extraction, then CTG + tunnel
- Socket bone grafted and CTG sutured with vertical mattresses

- After 3.5 months, implant + GBR performed
- Flapless ridge preservation can only maintain about 80-85% of buccal contour, add'l augmentation needed in high esthetic cases

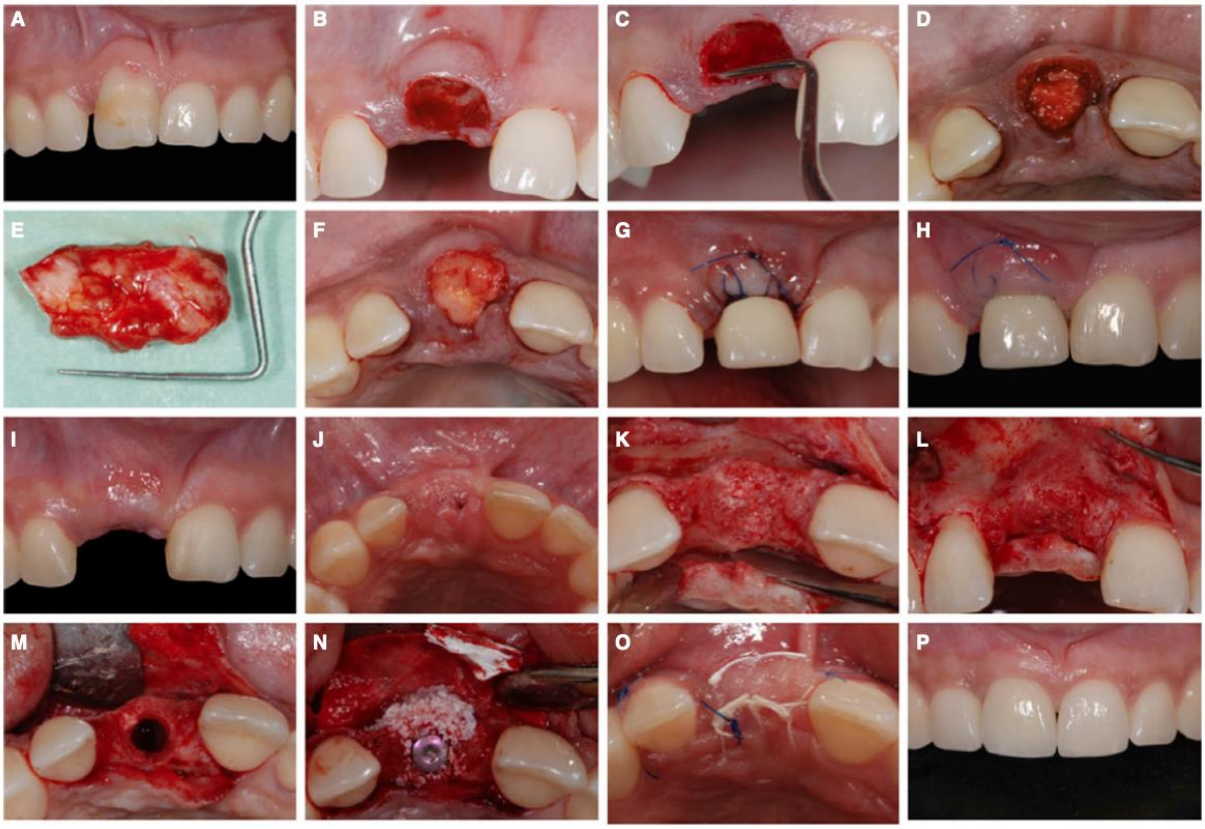


Fig. 2. (A) Ankylosed tooth #11 revealing a vertical soft- and hard-tissue deficiency. (B) Atraumatic tooth extraction. (C) Partial flap elevation using a tunnel technique. (D) Filling the extraction socket with a deproteinized bovine bone mineral embedded in a 10% collagen matrix. Placement of a connective tissue graft (E) underneath the elevated gingiva (F). (G) Postoperative situation after adjusting the temporary removable prosthesis to avoid excessive pressure on the augmented site. (H) Suture removal after 7 days. (I, J) Situation after a healing period of 3.5 months. (K, L, M, N) Implant placement with a simultaneous guided bone-regeneration procedure. (O) Suture removal after 1 week of healing. (P) Five-year follow-up of the all-ceramic implant-retained crown in the region #11 and the veneer on tooth #21, showing a harmonious esthetic outcome.

Clinical concept for hard and soft-tissue preservation with hard and soft tissue substitutes

- 31 y/o pregnant pt with fractured #12 and high lip line
- Implant could not be placed until after birth
- Soft tissue thickness did not need to be enhanced, so ridge preservation was performed with bone graft and membrane
- 6 months later, implant was placed without any augmentation

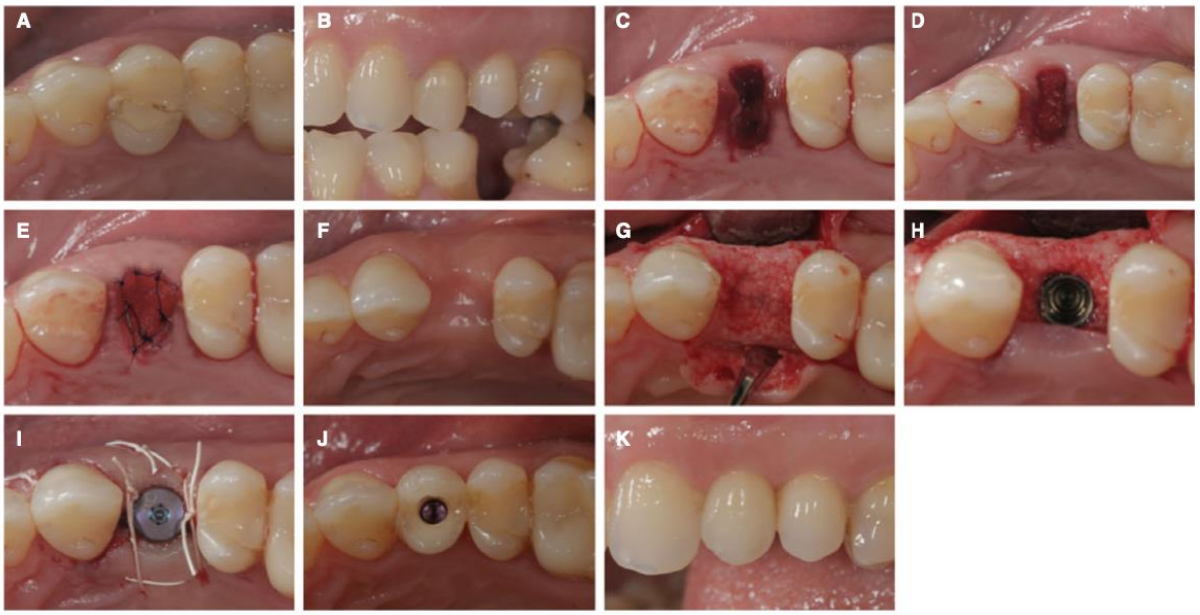


Fig. 3. (A, B) Mesiodistally fractured tooth #24. Situation after tooth extraction (C) and application of demineralized bovine bone matrix with collagen (D). (E) Collagen matrix of 8 mm diameter is sutured to the host gingival margin. (F) Six months after healing. Implant placement without any further augmentation (G, H) and transmucosal healing (I). (J, K) Clinical situation, after a further 6 weeks, with a screw-retained all-ceramic crown.

Clinical concept for hard and soft-tissue preservation (socket seal technique) with a hard-issue substitute and anautogenous soft-tissue graft

- 24 y/o male w/ pain on #8 with buccal fistula
- Large PARL but buccal bone intact coronally
- Pt was not ready for implant placement within 0-2 months [due to exams]
- Ridge preservation with hard and soft tissue (socket seal technique) performed
- After 7 mo, soft tissue contour was partially maintained
    - implant was placed and left for 3 months to allow healing

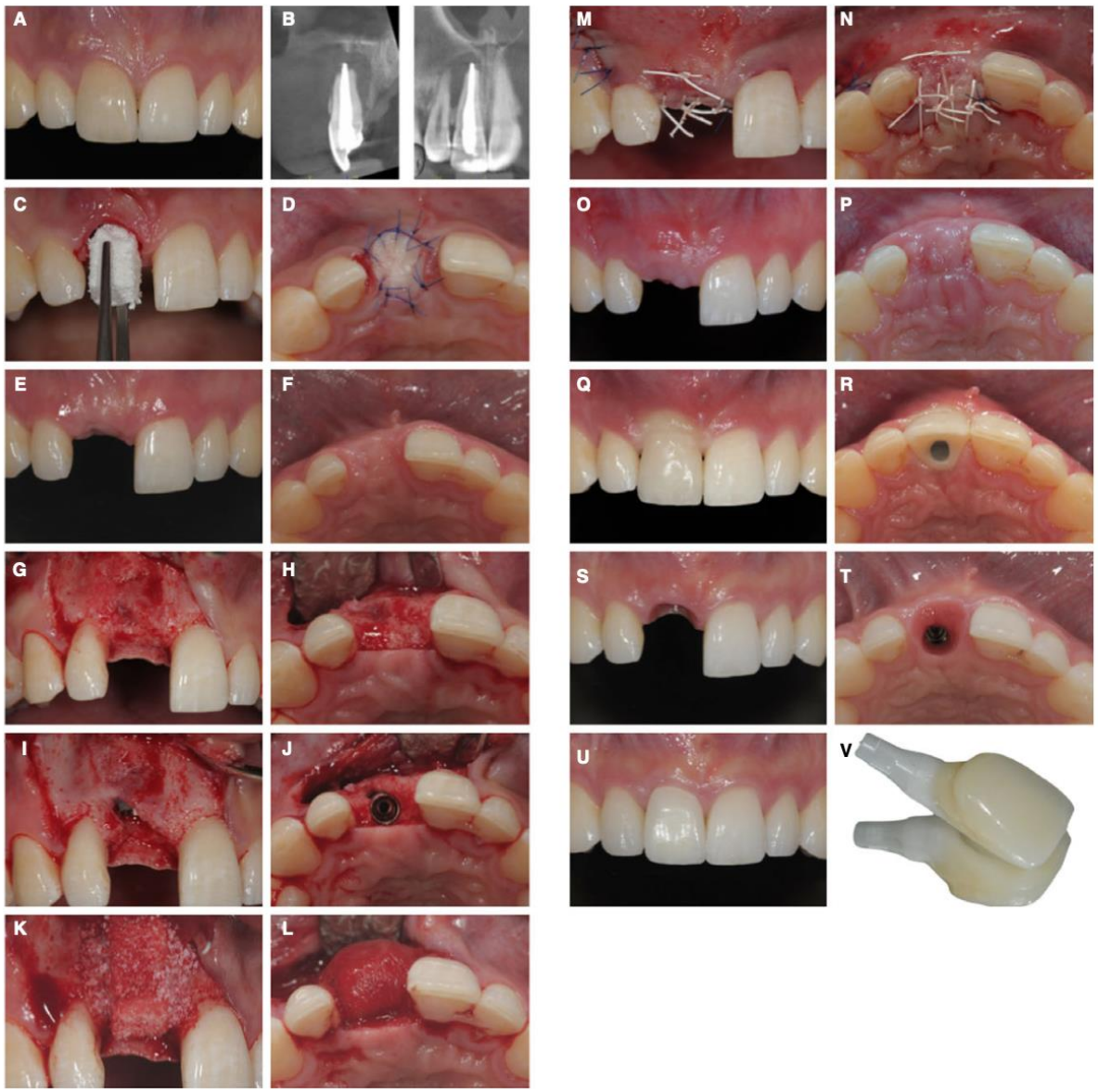


Fig. 4. (A) Central right incisor #11 with buccal fistulae and increased pocket depth. (B) Cone beam computed tomography reveals a large apical and pararadicular radiolucency involving also the apex of tooth #12. (C) Filling of the extraction socket, including the apical bone defect, with demineralized bovine bone matrix with collagen. (D) Sutured punch graft to the host soft-tissue margin of the extraction socket. (E, F) Clinical situation, 7 months later, showing a partially maintained soft contour. (G, H) Flap elevation revealing well-regenerated bone in the entire area except for some fibrous tissue distocoronally. (I, J) Implant placement in the correct prosthetically oriented position. (K, L) Buccal contour augmentation with demineralized bovine bone matrix collagen and a collagen membrane. (M, N) Submucosal healing of the implant for 3 months. (O, P) Clinical situation prior to abutment connection. Insertion of an implant-supported provisional crown (Q, R), allowing for soft-tissue conditioning of the peri-implant mucosa (S, T). (U, V) A screw-retained all-ceramic crown was inserted, showing an esthetically pleasing result with a harmonious soft-tissue appearance.

Clinical concept for hard tissue preservation using a guided bone regeneration technique

- 37 yo female with fistula on buccal #8 and 10 mm PD
  - Diagnosis: vertical root fracture
- After flap elevation, 14mm bone defect was present, unable to place implant
- Site was augmented with DBBM + autogenous bone and covered with collagen membrane
- Palatal pedicle flap used to close socket orifice

- Implant placed after 6 months of healing

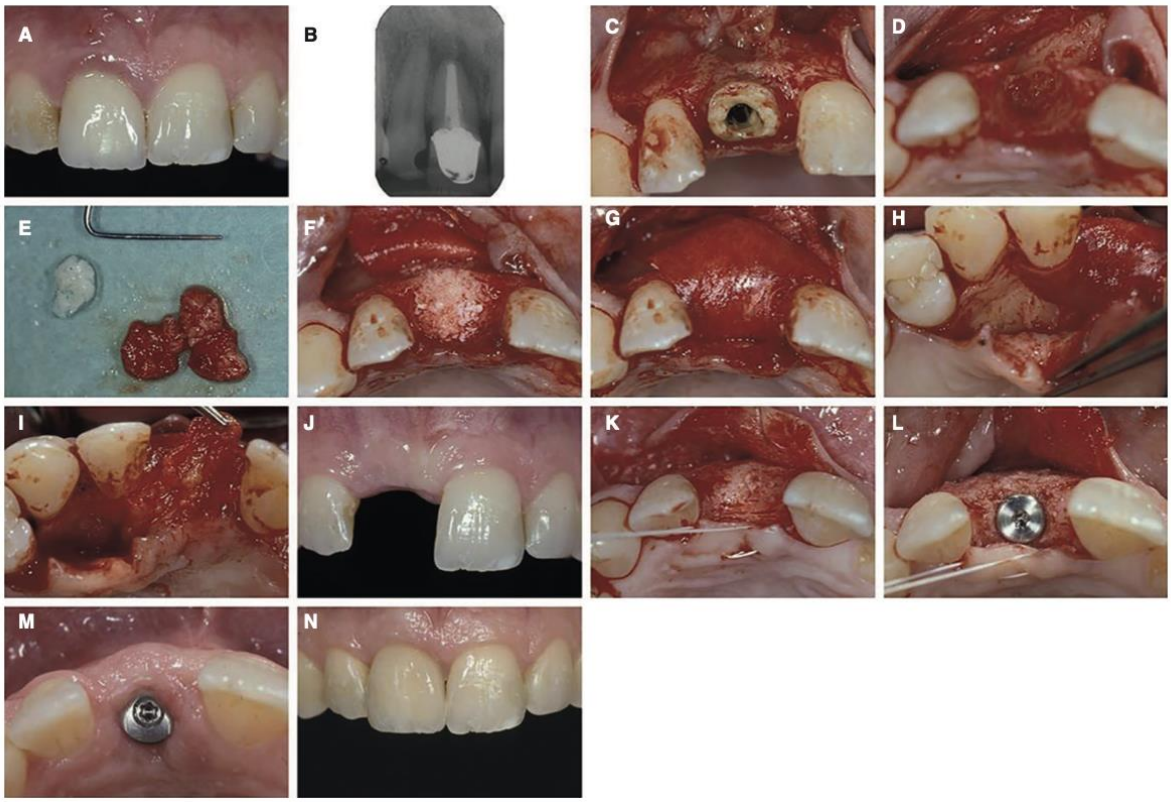


Fig. 5. (A) Buccal fistula of tooth #11 with a probing depth of 10 mm at the buccal aspect. (B) X-ray showing extensive root-canal treatment. The diagnosis was a vertical root fracture of tooth #11 after trauma. (C, D) Open flap access to extract the tooth. (E–G) Augmentation of the buccal bone contour using a demineralized bovine bone matrix material mixed with autogenous bone from the surrounding tissue and covered with a collagen membrane. (H, I) A palatal pedicle flap was prepared in order to close the orifice of the extraction socket. Following a healing period of 6 months (J), the implant could be inserted without any further intervention (K, L) and was left to heal transmucosally (M). (N) Clinical situation with a screw-retained porcelain-fused-to-metal crown.

Conclusions:
Decision for Ridge preservation in the esthetic zone should be made prior to tooth extraction
If implant can be placed within 0-2 months post-extraction, RP is not indicated
Exception: soft-tissue defects at time of tooth extraction
In this case: soft tissue preservation technique

Topic: Alveolar bone preservation (ARP)
Authors: Avila-Ortiz, G., Gubler, M., Romero-Bustillos, M., Nicholas, C., Zimmerman, M., Barwacz, C.
Title: Efficacy of Alveolar Ridge Preservation: A Randomized Controlled Trial
Source: J Dent Res. 2020 Apr;99(4):402-409.
DOI: 10.1177/0022034520905660
Reviewer: Daeoo Lee
Type: Randomized Controlled Trial
Keywords: bone graft(s), clinical studies/trials, digital imaging/radiology, tooth loss, alveolar bone atrophy, dental implants

Purpose: First, to evaluate the efficacy of ARP (allograft + dPTFE) therapy in comparison with unassisted socket healing (EXT). Second, to evaluate effect that local phenotypic factors play in the volumetric reduction of the alveolar ridge, whether ARP therapy is performed or not.

Material and methods: 59 patients recruited. Clinical, radiographic, volumetric (relating to bone and soft tissue) parameters were collected at baseline, 1 wks, 4 wks, 14 wks from post-op. Allograft was combination of 70% FDBA and 30% DFDBA (enCore; Osteogenics Biomedical). Non-absorbable membrane was dPTFE barrier membrane (Cytoplast TXT-200 Singles; Osteogenics Biomedical). Cross-mattress suture over the socket to stabilize the membrane. ARP group took amoxicillin or clindamycin tid 7 days; clean membrane with chlorhexidine swab two times a day; membrane removed at 4 wks.

Results: 53 out of 59 patients finished the study all the way to 14 week follow-up appointment; 27 for control and 26 for experimental group.
Baseline: comparable across groups

- Clinical Outcomes:
  - Mean keratinized mucosa width (KMW): minimal and comparable between groups.
- Bone Linear Outcomes:
  - Mean horizontal ridge width change: SS different (EXT −1.68 mm, ARP −1.07 mm)
  - Median Midbuccal crestal ridge height change (ΔBRH): SS different (EXT 1.17 mm, ARP 0.61 mm)
  - Midlingual crestal ridge height change (ΔLRH): SS different (EXT 0.70 mm (Not SS), ARP 0.47 mm)
- Bone Volumetric Outcomes:
  - Alveolar ridge bone volume % change (ΔBV): SS different (EXT -15.83%, ARP -8.36%); the observed volumetric reduction primarily affected the buccal-coronal aspect of the alveolar ridge.
- Soft Tissue Volumetric Outcomes
  - Alveolar ridge soft tissue contour change (ΔSTV): not SS different (EXT -21.1%, ARP -18.47%); ΔBV and ΔSTV has no correlation.
- Implant-Related Outcomes
  - SS that 48.1% of EXT sites needed additional bone augmentation at the time of implant placement, whereas it was only 11.5% for ARP.
- Patient-Reported Outcome Measures
  - Overall satisfaction high and comparable between groups.

Linear regression analysis of the effect of baseline phenotypic parameters on ridge volume change revealed that buccal bone thickness is a strong predictor of alveolar bone resorption.
The threshold of buccal bone thickness that would be associated with a maximum of 10% of bone volume loss is 1 mm of buccal bone thickness in the EXT group and 0.6 mm in the ARP group (90% specificity, 87% sensitivity)

Conclusions: Compared with unassisted socket healing, ARP therapy rendered superior maintenance of the alveolar bone after tooth extraction up to 14 wk and reduced need for bone augmentation with simultaneous implant placement. Also, buccal alveolar bone thickness is a strong predictor of the extent of bone resorption that ensues over the healing period that follows tooth extraction.

Topic: ARP
Authors: Christopher J. Walker, Thomas J. Prihoda, Brian L. Mealey, David J. Lasho, Marcel Noujeim, and Guy Huynh-Ba
Title: Evaluation of Healing at Molar Extraction Sites With and Without Ridge Preservation: A Randomized Controlled Clinical Trial
Source: J Periodontol 2017;88:241-249.
DOI: 10.1902/jop.2016.160445
Reviewer: Cyrus J Mansouri
Type: RCT
Keywords: Allografts; bone; cone beam computed tomography; dental implants; molar; tooth extraction.

Purpose:
To compare radiographic ridge changes in molar sites with or without ARP.

Material and methods:

- 52 patients were randomly assigned to the two treatment groups:
  - n = 26 ARP (with FDBA + dPTFE)
  - n = 26 USH (unassisted socket healing)
- Surgical protocol:
  - Molar teeth were atraumatically removed with a full thickness flap extending ≤ 3 mm from the socket crest.
  - If a bony wall was damaged > 50% the patient was removed from the study.
  - Removal of interseptal bone was completed to at least 6 mm but ≤ 10 mm from the highest crest of the extraction socket.
  - CollaPlug was placed for sites randomly allocated to USH.
  - Mineralized cortical FDBA was placed for ARP sites and covered with dPTFE membrane.
  - dPTFE membranes were removed after 21-28 days.
- CBCT scans were made within 72h of extraction and again 3 months post-extraction.
  - CBCT files were aligned via a pre-fabricated stent which was worn during the CBCT scan.
- Width and height of the ridge was measured radiographically.
- KTW was measured from buccal to lingual at baseline and prior to implant placement.
- Implants were placed after 3 weeks after the final CBCT.
  - Bone core biopsy was obtained prior to implant placement.
    - Findings were reported in a subsequent manuscript.
  - 4.7-, 4.8-, or 5-mm implants were placed, and bone grafting was added where necessary due to exposed implant surface.

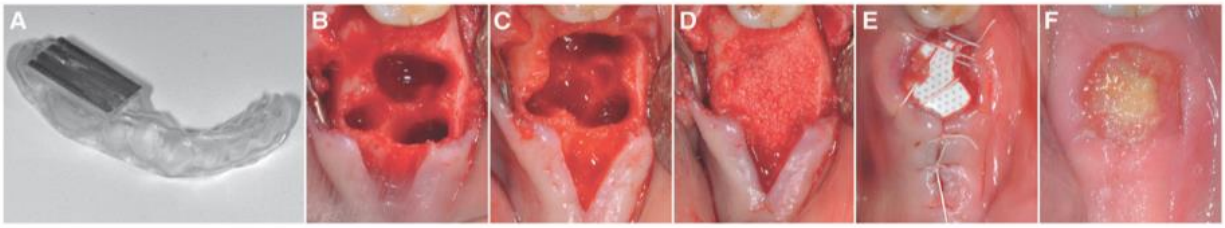


Figure 1.
A) *Radiographic stent with embedded anatomically referenced fiducial marker for registration of CBCT data.* ***B)*** *Patient from test group immediately postextraction.* ***C)*** *Removal of interseptal bone to 6 mm from socket crest.* ***D)*** *Socket filled with FDBA.* ***E)*** *dPTFE membrane placed, and flap stabilized with 4-0 PTFE suture.* ***F)*** *Healing after 3 weeks.*

Results:
A total of 40 pts completed the study

- n = 20 ARP (with FDBA + dPTFE)
- n = 20 USH (unassisted socket healing)
- 12 patients were lost due to dehiscence of the buccal plate > 50%.

Dimensional loss was significantly higher on the buccal aspect for USH sites.

- Height loss of 2.6 mm for USH vs 1.12 mm for ARP (SSD)

No significant difference was found in reduction in KTW in mandibular molar sites.
No significant difference was found in ridge width between groups.

- 2/3 of ridge width reduction occurred on the buccal for USH sites.
- Ridge width resorption was evenly distributed between buccal/lingual in ARP sites.

Bone grafting at the time of implant placement was necessary in 25% of USH sites but only 10% of sites which received ARP.

Conclusion:
Significantly more ridge height resorption occurs in sites with unassisted healing, of which the majority of resorption occurs on the buccal aspect. With ARP therapy, ridge width resorption was not significantly

attenuated, but resorption became evenly distributed between the buccal and lingual aspects of the ridge. Ridge preservation does not prevent the collapse of the ridge but can minimize it

Topic: FDBA for Ridge Preservation
Authors: Iasella JM, Greenwell H, Miller RL, Hill M, Drisko C, Bohra AA, Scheetz JP.
Title: Ridge preservation with freeze-dried bone allograft and a collagen membrane compared to extraction alone for implant site development: a clinical and histologic study in humans.
Source J Periodontol. 2003 Jul;74(7):990-9.
DOI: 10.1902/jop.2003.74.7.990.
Type: Clinical Study
Reviewer: Veronica Xia
Keywords: ridge preservation, bone allograft

Background:

- Bone resorption post-extraction
  - Greatest amount of bone loss in horizontal dimension on the facial aspect of ridge
  - Loss of vertical ridge height (most pronounced on buccal)
  - Overall: decreased ridge → more palatal/lingual position
- Ridge preservation: preserve original ridge dimension

Purpose:

- Compare post-extraction dimensional changes following extraction alone or extraction plus ridge preservation with intrasocket mineralized free-dried bone allograft (FDBA) and collagen membrane
  - Secondarily: looking at histologic composition of filled alveolus
  - Thirdly: 4 vs 6 month implant placement time evaluated to investigate effect on bone quality or implant success rate
  - Fourthly: evaluate effect of collagen membrane on soft tissue thickness vs extraction alone

Material and methods:

- 24 patients
  - Extraction alone (EXT) or ridge preservation (RP--FDBA/collagen membrane)
    - Ridge preservation group: FDBA hydrated in 50mg/ml tetracycline solution (250mg tetracycline with 5ml sterile saline)→collagen membrane extend 3mm past alveolar crest
- Ridge dimensions and soft tissue thickness measured
- Core removed from extraction site for histologic analysis
- Implants placed (1 and 2 stage)

Results:

- Clinical indices (PI, GI and BOP)
  - NSSD between groups
- Horizontal Alveolar Ridge Width (SSD between groups)
  - EXT: mean loss 2.6+/-2.3mm
  - RP: mean loss 1.2+/-0.9mm
- Vertical Ridge Height
  - SSD between EXT and RP (favored) at the buccal, mesial, and distal sites (NSSD at palatal/lingual)
- Histologic Evaluation
  - EXT healed with less total bone/more trabecular space than RP
- Soft Tissue Changes
  - EXT: 2.1+/-1.3mm
  - RP: 2.6+/-0.9mm (mid-crestal thickness over collagen membrane)
  - SSD between groups at buccal surface
    - EXT: gained thickness

        - RP: lost thickness
    - NSSD before and after implant placement

Conclusions:

- RP limited loss of hard tissue ridge width and provided gain in ridge height when compared to extraction alone
    - Most predictable maintenance of ridge width, height, and position
- Extraction alone results in >/=1mm loss of ridge height
- Greatest loss is horizontal ridge width primarily at buccal (also where vertical loss greatest)
    - Buccal resorption→ridge located more palatal/lingual
- RP reduce buccal resorption (more ideal implant placement)
- RP group loss some soft tissue thickness, while EXT group gained around 0.5mm thickness
    - May be due to membrane interference with flap vascularity
- Maxillary arch and subjects >/= 50 years old have greater vertical/horizontal resorption after extraction

Topic: Extraction Ridge Preservation
Authors: Avila-Ortiz G, Elangovan S, Kramer KW, Blanchette D, Dawson DV.
Title: Effect of alveolar ridge preservation after tooth extraction: a systematic review and meta-analysis. J
Source: J Dent Res. 2014 Oct;93(10):950-8.
DOI: 10.1177/0022034514541127.
Type: Systematic Review
Reviewer: Trisha Nguyen-Luu
Keywords: alveolar bone loss, alveolar bone atrophy, tooth loss bone remodeling, alveolar bone grafting, evidence-based dentistry
Background:
Purpose: to compare effect of ridge preservation in preventing alveolar ridge volume loss post-extraction versus tooth extraction without socket preservation in non-molar teeth
Material and methods:

- Electronic and manual search for randomized clinical trials
- PICO: what is the effect of alveolar ridge preservation (ARP) via socket filling following non-molar tooth extraction alone in preserving the alveolar ridge dimensions, after a minimum healing of 12 week reported in RCT in adult humans subjects?
- Outcome measures: horizontal ridge changes, vertical ridge change, influence of variable such as flap elevation, membrane usage, type of bone substitute used

Results:

- 8 studies were included for qualitative analysis
- Strong positive ridge preservation effect in favor of ARP
    - Buccolingual width: 1.89 mm
    - Midbuccal height: 2.07 mm
    - Midlingual height: 1.18 mm
    - Mesial Height Changes: 0.48 mm
- No evidence of significant ridge preservation effect on the Distal Height → 0.24 mm (NSSD)
- Sites that had flap elevation exhibited less average midbuccal and midlingual height loss
    - Generally thought that flap elevation interrupts periosteal vascular supply and increase postsurgical local inflammation resulting in more bone loss but recent evidence shows that flap elevation does NOT promote alveolar bone loss
- Use of barrier membrane had a strong beneficial effect on preservation of midbuccal and midlingual alveolar bone height
- Xenograft or allograft has a beneficial effect in midbuccal alveolar bone height preservation vs. alloplast
- Buccolingual width, mesial and distal height changes were not influenced by variations on flap elevation, membrane use and type of bone grafts

Conclusions

- ARP may significantly prevent alveolar bone remodeling post-extraction
    - some degree of horizontal and vertical bone loss should still be expected due to local and systemic factors not fully understood
- Factors influencing ridge resorption patterns:
    - Number of neighboring teeth to be extracted, socket morphology (single vs. multi-root teeth), socket integrity, periodontal biotype (bony buccal plate and soft tissue thickness), grafting material, smoking, systemic factors, patient compliance
- Buccolingual width, mesial and distal height ridge changes were not influenced by variation on flap elevation, membrane usage and type of bone grafts
    - Take information with caution b/c of limited number of studies
-

Topic: buccal plate thickness
Authors: Spinato S, Galindo-Moreno P, Zaffe D, Bernardello F, Soardi CM
Title: Is socket healing conditioned by buccal plate thickness? A clinical and histologic study 4 months after mineralized human bone allografting
Source: Clin Oral Implants Res. 2014 Feb;25(2):e120-6.
DOI: 10.1111/clr.12073
Type: clinical/histological
Reviewer: Erin Schwoegl

Purpose: to evaluate the healing of sockets grafted with mineralized human bone allograft (MHBA) and any influence of the thickness of the buccal plate

Material and methods:

- Included 31 extraction sockets
- Sockets randomly divided into control (CG) and MHBA grafted (TG) groups
- Ridges were characterized based on buccal bone thickness:
    - A: 1mm or less
    - B: >1mm
- Implants were placed after 4 months of healing
- Bone cores were taken at time of placement histologic analysis

Results:

Difference in buccal height:

- CG-a: -0.17mm
- TG-a: -0.27mm
- SSD

Difference in buccal width:

- TG-a: 0.55mm
- CG-a: 2.67mm
- CG-b: 1.17mm
- SSD

Increase in bone amount:

- CG-b: 28.17%
- CG-a: 16.98%

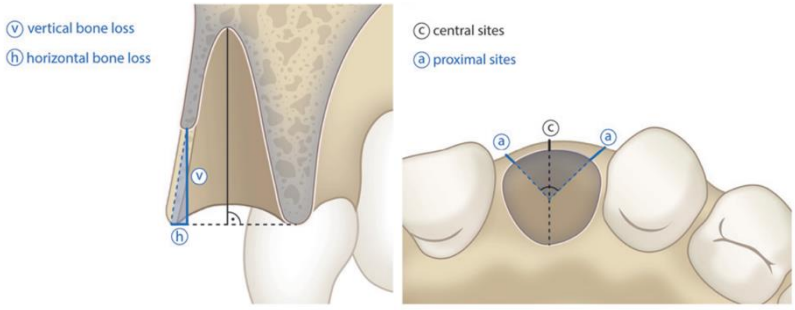
- SSD

Soft tissue amount:

- TG-b: 54.21%
- TG-a: 56.91%
- CG-a: 83.01%
- CG-b: 71.83%
- SSD

Conclusions:
- Sites with thin buccal plates had worse healing outcomes
- MBHA served to maintain the size of the ridge vs the control groups

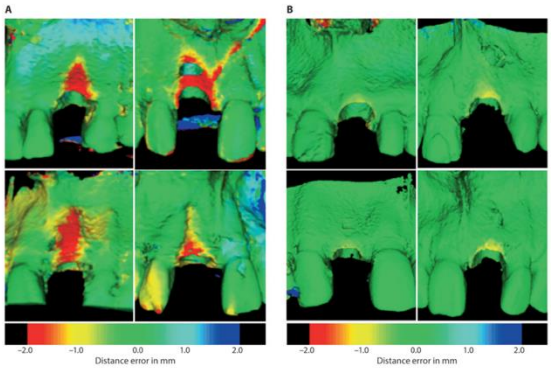
Topic: Ridge Alteration
Authors: Chappuis V, Engel O, Reyes M, Shahim K, Nolte LP, Buser D.
Title: Ridge alterations post-extraction in the esthetic zone: a 3D analysis with CBCT.
Source: J Dent Res. 2013 Dec;92(12 Suppl):195S-201S.
DOI: 10.1177/0022034513506713
Type: Prospective Study
Reviewer: Brook Thibodeaux
Keywords: bone remodeling, bone resorption, three-dimensional imaging, clinical trial, dental implants, maxilla

Purpose: To examine dimensional alterations post tooth extraction of the facial bone wall in the esthetic zone.
Materials and Methods:
- 39 patients w/ need for single tooth extraction in max anterior.
- Extraction w/o flap elevation, atraumatic technique, collagen sponge placed into socket (tissue cone).
- Recall at 2, 4, 6, 8 weeks post op
- Two CBCTs: one immediately post ext, one at 8wks post op
- Baseline: Facial bonce thickness measured 1, 3, 5mm from most coronal point of bone crest
- 

Results:
- Baseline
  - Facial bone wall thickness= 0.8mm, Proximal facial bone thickness= 1.0mm, SS
  - Facial wall thickness </=1mm 60% of central sites, 59% of proximal sites
- Dimensional change
  - Central sites: progressive bone resorption, vertical bone loss= 5.2mm (48% of original bone height), horizontal bone loss= 0.3mm or (3.8% of original bone wall width)
  - Proximal sites: SS less resorption vertically and horizontally, vertical bone loss= 0.5mm (4.5% of original bone height), horizontal bone loss= 0.0mm or (0% of original bone wall width)
- Characteristic Bone Resorption patterns
  - 1mm was a critical facial bone wall thickness

- SS bone resorption associated with a thin wall phenotype (</=1mm)
    - Vertical bone loss= 7.5mm (62.3%), Horizontal bone loss= 0.8mm (10.5%)
- Thick wall phenotype had a less pronounced resorption pattern (>1mm)
    - Vertical bone loss= 1.1mm (9.1%), Horizontal bone loss= 0mm (0%)
- SSD between vertical bone loss for thin vs thick wall phenotypes

Figure 3.
Characteristic bone resorption patterns. **(A)** A thin-wall phenotype showed a facial bone wall thickness of ≤ 1 mm and revealed a progressive bone resorption pattern after 8 wks of healing. **(B)** A thick-wall phenotype, with a facial bone wall thickness of > 1 mm, exhibited a less-pronounced bone resorption pattern after 8 wks of healing.



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Conclusions: This study showed that facial bone resorption takes place in the anterior maxilla, ant that facial bone wall thickness in the central area determines the resorption extent. Thin wall phenotypes experience much more severe resorption when compared to thick.

Topic: alveolar ridge preservation
Authors: Mendez et al
Title: Comparison of allografts and xenografts used for alveolar ridge preservation. A clinical and histomorphometric RCT in humans
Source: Clin Implant Dent Relat Res. 2017;19:608–615
DOI: 10.1111/cid.12490
Reviewer: Amber Kreko
Type: randomized clinical trials
Keywords: allograft, alveolar ridge reconstruction, bone grafting, tooth extraction, xenograft

Purpose: To compare the healing of allografts and xenografts applied for alveolar ridge preservation

Material and methods:
- 20 subjects needing single rooted tooth extraction prior to implant
    - Two groups: DFDBA (allograft)in one group and DBBM-Collagen (Bio-Oss, bovine bone in porcine collagen) in the second group.
- After extraction, measurement performed using stent to measure vertical distance. Horizontal measurements were performed using a caliper.
- After 6 months, flaps were elevated and measurements were taken with stent, biopsies were collected, and implant was placed.

Results:
- Ridge width
    - Allograft went from 7.8mm at baseline to 6.4mm at 6 months.
    - Xenograft went from 8.7mm at baseline to 6.1mm at 6 months
    - No significant difference between groups but significant difference from baseline to 6 months.
- Vertical bone dimensions
    - Allograft lost 0.6 (mesial), 0.5 (center), and 0.1 (distal) mm measured using custom stent
    - Xenograft lost 1.1, 0.4, and 0.9mm measured using custom stent
    - No significant difference between groups.
- Histologic analysis
    - Allograft had 25.5% new bone and 33.8% residual graft material

    - Xenograft has 35.3% new bone and 22.2% residual graft material.
    - No significant difference between groups.

Conclusions: Both grafting materials are suitable for alveolar ridge preservation.

Topic: Socket preservation
Authors: Corbella S, et al
Title: Histomorphometric Results After Post extraction Socket Healing with Different Biomaterials: A Systematic Review of the Literature and Meta-Analysis
Source: *Int J Oral Maxillofac Implants*. 2017;32(5):1001–1017
DOI: 10.11607/jomi.5263
Reviewer: Tam Vu
Type: Systematic Review and Meta-Analysis
Keywords: histomorphometric, biomaterial, bone graft substitute, socket preservation

Purpose: to evaluate histomorphometric outcomes to determine which bone graft material is most efficient for socket preservation following extraction

Material and methods: manual and electronic search

Results:

- Biomaterials tested
    - None (collagen plug and sponges, fibrin sponge, resorbable membranes alone)
    - Bovine bone (BB)
    - Allograft (AG, not freeze dried))
    - Porcine bone (PB)
    - Hydroxyapatite (HA)
    - Magnesium-enriched HA
    - Freeze-dried bone allograft (FDBA)
    - Calcium sulphate (CS)
    - Combo of HA and beta-tricalcium phosphate (β-TCP)
    - Other biomaterials (tricalcium phosphate, rhPDGF, mineral collagen bone substitute)
- Meta-Analysis of Comparative Studies
    - BB vs no bone substitute: SSD favoring no bone group
    - Mg-enriched HA vs no bone: SSD favoring Mg-enriched HA
    - PB vs no bone: SD favoring PB
    - AG vs no bone: NSSD between two groups

Conclusion:

- Based on histomorphometric analysis, no evidence of superior biomaterial with regards to new bone formation.
    - Xenografts appears to preserve bone volume over time compared to allografts
    - Calcium sulphate and beta-tricalcium phosphate resorbs faster than other biomaterials tested
- Comparative studies shows PB and Mg-enriched HA to significantly produce higher amounts of new bone volume.
    - BB reduced percentage of new bone volume
    - AG did not show more new bone formation

Topic: Ridge Preservation and sealing material
Authors: Canullo, L., Pesce, P., Antonacci, D., Ravidà, A., Galli, M., Khijmatgar, S., Tommasato, G., Sculean, A., Del Fabbro, M.
Title: Soft tissue dimensional changes after alveolar ridge preservation using different sealing materials: a systematic review and network meta-analysis
Source: Clin Oral Investig. 2022 Jan;26(1):13-39

DOI: 10.1007/s00784-021-04192-0
Reviewer: Daeoo Lee
Type: Systematic review/Meta-Analysis
Keywords: Alveolar ridge preservation; Collagen membrane; Collagen sponge; Crosslinked; Multidimensional scale; Network meta-analysis; Non-crosslinked; Predictive interval; Ranking; SUCRA; Soft tissue

Purpose: Focus Questions: 1) What ARP biomaterials produced the most beneficial effects compared spontaneous healing in terms of Keratinized Mucosa Thickness (KMT) as well as horizontal and vertical dimensional soft tissue changes?
(2) What ARP biomaterial was associated with the lowest three-dimensional soft tissue changes post-extraction compared to other materials?

Material and methods: Literature search conducted through electronic databases (MEDLINE, EMBASE, Cochrane, Scopus). Manual search also performed on selected journal. The main study outcomes were changes in KMT, changes in vertical buccal and palatal/lingual soft tissue height, and changes in horizontal width.

Results: 22 articles included in the systematic review, and 11 articles were included in the meta-analysis; studies included were RCT.
Ranking for keratinized mucosa thickness changes: Collagen sponge (ColS) > CM-NonCross > (CM-Cross, resorbable synthetic membrane, and control group similar)
Ranking for vertical buccal mucosa height changes: CM-Cross > ColS > CM-NonCross
Ranking for horizontal width changes: Autogenous soft tissue > CM-NonCross

Discussion: An important finding was that KMT represented the most homogeneous outcome. The findings on mucosal thickness changes were in agreement that spontaneous healing leads to increased bone resorption but greater soft tissue thickness. In other words, post-extraction soft tissue changes may potentially mask the true extent of alveolar ridge atrophy.

Conclusions: The use of crosslinked collagen membranes and autogenous soft tissue grafts, with a minimum of 6-week follow-up, represented the best biomaterial choices for sealing sockets during ARP in terms of minimizing post-extraction soft tissue dimensional shrinkage.

Topic: ARP
Authors: Robert A. Wood and Brian L. Mealey
Title: Histologic Comparison of Healing After Tooth Extraction With Ridge Preservation Using Mineralized Versus Demineralized Freeze-Dried Bone Allograft
Source: J Periodontol 2012;83:329-336.
DOI: 10.1902/jop.2011.110270
Reviewer: Cyrus J Mansouri
Type: Histologic
Keywords: Alveolar bone loss; bone resorption; bone transplantation; dental implants; tooth extraction.

Purpose:
To histologically compare healing of non-molar extraction sites grafted with DFDBA and FDBA for ridge preservation. A secondary objective was to compare dimensional changes of the ridge height and width.

Material and methods:
40 pts were recruited for the study (n = 20 DFDBA; n = 20 FDBA).
- Single-rooted non-molar tooth planned for extraction and interested in implant therapy.

All graft material was procured from a single donor for standardization.
Surgical protocol:
- Minimally traumatic extraction performed with minimal invasiveness.
- DFDBA or FDBA was placed in the socket and a collagen membrane was placed over the graft material and secured with non-resorbable sutures.

- Minor dehiscences were included and treated with a longer-resorbing collagen membrane (Socket Repair Membrane, Zimmer Dental).

Post-op:
- Amoxicillin 500 mg TID/7 days; CHX 0.12% BID/14 days.
- Sutures removed after 2 weeks.
- CBCT scan was made after 3 months.

Implant placement 18-20 weeks after extraction:
- A 2-mm core biopsy was taken from each site.
    - Histomorphometric analysis performed to determine % vital bone, residual graft particles, and CT/other non-bone components.

Results:
- A total of 32 pts completed the study (n = 16 DFDBA; n = 16 FDBA).
- No differences were found regarding ridge dimensional change or in percentage of CT/other non-bone components between groups.
- Sites which received DFDBA showed significantly greater percent vital bone than FDBA (38.42% vs 24.63%).
- Significantly lower residual graft particles were found in DFDBA than FDBA (8.88% vs 25.42%).

Conclusion:
Significantly greater bone formation was demonstrated by grafting with DFDBA.

Topic: Complications and Cost-effectiveness
Authors: Barootchi S, Tavelli L, Majzoub J, Stefanini M, Wang HL, Avila-Ortiz G.
Title: Alveolar ridge preservation: Complications and cost-effectiveness.
Source: Periodontol 2000. 2022 Dec 29.
DOI: 10.1111/prd.12469.
Type: Review
Reviewer: Veronica Xia
Keywords: complications, cost-effectiveness, alveolar ridge preservation

Purpose:
- Analysis of complications and cost-effectiveness of different modalities of alveolar ridge preservation

Discussion:

<u>Complications</u>
- Unanticipated adverse event that occurs as a direct manifestation of teeth extraction and/or alveolar ridge preservation therapy
- After tooth extraction (unassisted socket healing)
    - Alveolar osteitis: severe postop pain/halitosis due to failure in the development of a stable blood clot (4% occurrence)
    - Acutely infected alveolus: pain/edema with/without suppuration/fever (20% occurrence)
- Alveolar Ridge Preservation
    - Earlier onset of complications and adverse events
        - Infection during first two weeks postop: 2.8%-9.1% incidence rate
        - Delayed healing with persistent swelling, intense erythema, spontaneous bleeding, ulceration persisting after first 2 weeks
        - Premature loss of bone graft practices: 2.9%-14.3% incidence rate
        - Membrane exposure
        - Membrane perforation of mucosa
        - Premature exfoliation of nonabsorbable membranes
        - Loss of keratinized mucosa width
            - Sites where full thickness flap raised
    - Delayed adverse events/complications

        - Insufficient bone availability at previously preserved sites: 2.7%-57% incidence rate
        - Nonintegrated bone graft particles
        - Lack of implant primary stability (4-10%)
        - Failure of implant osseointegration (3.3-20%)

Cost-effectiveness

- Effectiveness
    - Greatest linear resorption at facial/coronal aspect of alveolar ridge in horizontal dimension (mean loss 3.4mm) → 40% prevented with alveolar ridge preservation
    - Dimensional changes within first 3 months; stabilization of bone remodeling take up to 1 year
- Technical variable on Dimensional Changes
    - Flap elevation SSD increaser horizontal/midbuccal vertical bone loss
- Influence of Local Anatomical Features on Resorption Patterns
    - SS correlation between average crestal buccal bone thickness and linear bone changes
- Cost-effectiveness of alveolar ridge preservation
    - Xenogenic bone graft: highest cost (followed by allograft and alloplast)
    - Allograft and xenograft: higher costs, superior performance (reduced resorption)
        - NSSD between allograft/xenograft in capacity to reduce ridge remodeling
    - SS correlation between expenditure on barrier membrane and less horizontal/vertical ridge resorption
        - NSSD correlation with bone graft cost

Conclusions:

- Most common postop complications with alveolar ridge preservation: infection, membrane exposure/exfoliation, extravasation of bone graft particles
- Thickness of facial bone wall is strong predictor of ridge resorption (especially with thin bone phenotype <1mm)
- Allogenic/xenogenic bone have higher costs, but also superior preservation performance than alloplast
- Barrier membranes for socket sealing over grafted sockets (minimize resorption) → decreased return on monetary investment beyond $50.

Topic: Extraction Ridge Preservation
Authors: Araújo, Flavia Sukekava, Jan L Wennström, Jan Lindhe
Title: Tissue modeling following implant placement in fresh extraction sockets
Source: Clin Oral Implants Res 2006 Dec;17(6):615-24.
DOI: 10.1111/j.1600-0501.2006.01317.x.
Type:
Reviewer: Trisha Nguyen-Luu
Keywords: dogs, extraction socket, healing, histology, immediate implant
Background:

- Marked buccal bone resorption occurs after tooth extraction
- Implant placement in a fresh socket does not interfere with tissue remodeling process
- Marginal portion of implant after 3-4 months of healing was devoid of bone contact
    - marginal portion of buccal bone wall contains proportionally larger amounts of bundle bone compared to the lingual wall
    - Bundle bone is a tooth related tissue → after tooth loss will remodel and disappear causing buccal dehiscence
- Studies show that implant placed in fresh extraction socket may result in early hard tissue fill of marginal defect but in later phases of tissue remodeling, the newly formed marginal bone may be lost.

Purpose: To test the hypothesis that "osseointegration may be lost as a result of the physiological modeling that occurs following tooth extraction and implant installation."
Material and methods:

- 7 beagle dogs provided the 3rd and 4th premolars in the right and left mandibular quads

- 5 dogs underwent implant placement on the right side of the mouth first and 2 months later implants were placed on the left.
    - Teeth were root canal treated
    - Buccal and lingual full thickness flap was elevated and distal root was extracted.
    - Straumann Standard implant 4.1 mm wide x 6 or 8 mm length were immediately placed were the SLA coated surface was at the level or slightly apical to the bony crest of the extraction socket
    - Healing caps were placed for semi-submerged healing
- 2 dogs had both implants placed on the right and left side of the mouth at the same time and biopsies were obtained immediately.
- Dogs were sacrificed.
- B/I: the most coronal point of contact btw bone and implant

Results:

- Histological observations:
    - Day 0:
        - Implant pitches contacted cortical bone in the middle and apical portions of the socket but most areas a blood clot occupied space bt implant and bone.
        - buccal bone wall of socket is markedly thinner compared to lingual
        - Crest of buccal + lingual wall of socket was located coronal to the SLA border of implant
        - Distance between crest of bone and implant surface was similar on the buccal and lingual aspect (0.4-0.2 mm)
    - 4 Weeks:
        - gap between implant and marginal bone from Day 0 is occupied byprovisional CT and newly formed woven bone, parallel-fibered and lamellar bone
        - center of bucaal and lingual bone walls was made of old lamellar bone surrounded by newly formed bone that contacted implant surface
        - large numbers of osteoclast on the outer bone crest and large number of bone multicellular unites on the central portiosn of walls
        - crest of lingual bone wall was closer to SLA border , buccal crest was at varying distance
    - 12 weeks:
        - Peri-implant mucosal margin was either at or slightly apical to implant shoulder
        - 2 mm barrier epithelium + zone of CT attachment was longer at the buccal than lingual of implant
        - Buccal bone crest was more apical to SLA border
        - Presence of primary osteons with similar amount of wove, parallel-fibered and lamellar bone in the contact regions between implant and bone
- Histometric Observations:
    - Day 0:
        - Buccal Bone crest: -0.4 mm from the SLA border
        - Lingual bone crest: 1.1 mm coronal to the SLA border
        - Peri-implant mucosal margin: 0.6 mm apical to implant shoulder on the buccal
            - 0.6 mm coronal to implant shoulder on the lingual
    - 4 weeks:
        - Buccal bone crest: -0.7 mm (marked reduction)
        - Lingual bone crest: 1 mm
        - Marginal level of B/I: 0.8 mm on buccal and 0.4 mm on the lingual apical to SLA border.
        - Peri-implant mucosal margin was close level of implant shoulder on the buccal and lingual aspect
        -
    - 12 Weeks: bone crest was 2.1 mm on the buccal and 0.4 mm on the lingual

- **Buccal bone crest was located~ 2.5 mm apical to lingual bone crest**
- Marginal level of B/I: 2 mm on the buccal and 0.1 mm on the lingual apical to SLA border
- Peri-implant mucosal margin: 0.6 mm below the implant shoulder on the buccal and 0.2 mm below the implant shoulder on the lingual
- Apical termination of the barrier epithelium= 2.2 mm on the buccal (closer to the B/I contact) and 2.1 mm on lingual

Conclusions

- Gap between implant and extraction socket becomes filled with coagulum
- After 4 weeks the coagulum is replaced with newly formed bone that makes contact with the rough surface of the implant in the marginal gap region
    - Buccal and lingual bone undergoes marked surface resorption
    - Bundle bone in marginal region was resorbed
    - Marked reduction in the height of the thin buccal hard tissue wall
- Between 4- 12 weeks, height of buccal bone crest is further reduced
    - Resulting in buccal dehiscence of > 2 mm
    - Related to functional adaption of alveolar ridge occurred after loss of teeth
- Crest of lingual bone wall was mostly unchanged throughout healing process
- Immediate buccal bone loss is due to surgical trauma (flap elevation and detachment of periosteum)

Topic: grafting the gap
Authors: Sanz, M., Lindhe, J., Alcaraz, J., Sanz-Sanchez, I., Cecchinato, D.
Title: The effect of placing a bone replacement graft in the gap at immediately placed implants: a randomized clinical trial.
Source: Clin. Oral Impl. Res.28,2017 / 902–910
Type: RCT
Reviewer: Erin Schwoegl

Purpose: To evaluate dimensional changes to crestal bone after filling gap with bone graft in immediate implant sites
Material and methods:

- 86 pts included
    - Group A (43 test sites): gap between implant surface and bone plates filled with demineralized bovine bone mineral with 10% collagen (DBBM-C)
    - Group B (43 control sites): no bone replacement materials used
- Measurements made at baseline and 16 weeks re-entry
- Atraumatic extraction and surgical placement of implants

Results:
- Buccolingual dimension reduction: 25% for test and 30% control; NSSD between groups
- Mean reduction in alv crest width (buccolingual dimension 1mm below crest): 11% for test and 16% for control; NSSD
- Horizontal crest reduction: 29% for test and 38% in control; SSD
- Gap size reduction: 61% for test gap fill vs 71% control gap fill; SSD
- Vertical defect depth and vertical change was NSSD
- Thin buccal sites had significantly less reduction in test vs control sites
- Anterior sites sig less reduction in horizontal crest dimensions in test sites vs control
    - Sig less horizontal gap fill
- Large buccal gap (≥2mm) reduction: NSSD test vs control

Conclusion:
- Placing bone graft consisting of DBBM-C sig reduced horizontal bone resorption of the buccal bone after immediate implants