

*Key Essentials for Successful Bone Grafting Techniques for Ridge Preservation and Augmentation for Implants and Prosthetic Dentistry*

1

**Presentation Overview**

- Classification of Alveolar Defects
- What are the Keys to Successful Bone Grafting?
- Why Socket Preservation and Ridge Augmentation?
- What are the Different Bone Grafting Products?
- What is Advanced Extraction Therapy?
- Why, When and How do I Use of Membranes?

2

**Treatment Planning: How do we Classify Alveolar Defects?: A Historical and Contemporary Perspective**

3

**Classification of Alveolar Defects**  
Seibert, JS (1983)

Class I: bucco-lingual loss of tissue with normal ridge height in a apico-coronal dimension 33%

Class II: apico-coronal loss of tissue with normal ridge width in a bucco-lingual dimension 3%

Class III: combined bucco-lingual and apico-coronal loss of tissue resulting in loss of normal height and width 56%

4

**Classification of Alveolar Defects**  
Allen, Gainza et al (1985)

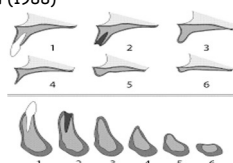
Similar classification to Seibert et al

| Criteria for classification                               | Seibert's Nomenclature | Allen's Nomenclature |
|---|------------------------|----------------------|
| Horizontal or buccal tissue loss with normal ridge height | Class I                | Type B               |
| Vertical tissue loss with normal ridge height             | Class II               | Type A               |
| Combined horizontal and vertical bone loss                | Class III              | Type C               |

- Vertical defect (Type A)
- Horizontal defect (Type B)
- Mixed/combined defect (Type C)

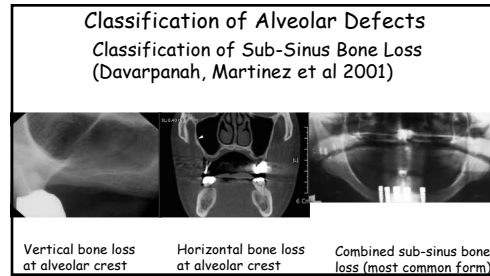
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**Classification of Alveolar Defects**  
Cawood & Howell (1988)



Classification of the general dimensional changes following tooth loss; in this classification the maxilla and mandible show different absorption patterns

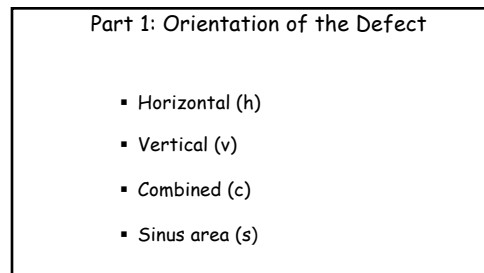
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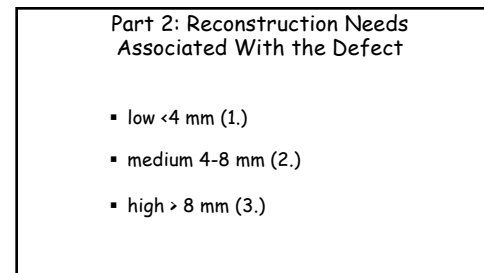
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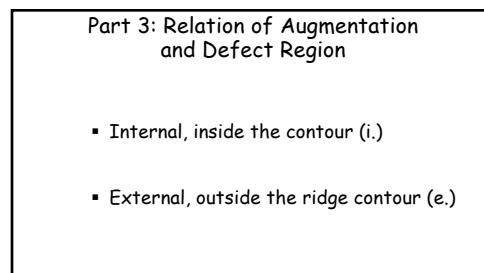
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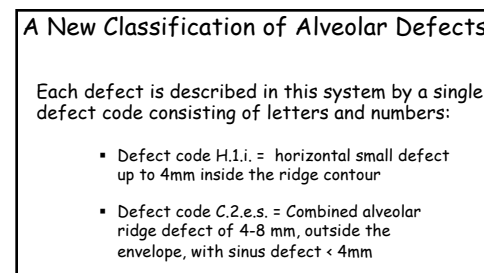
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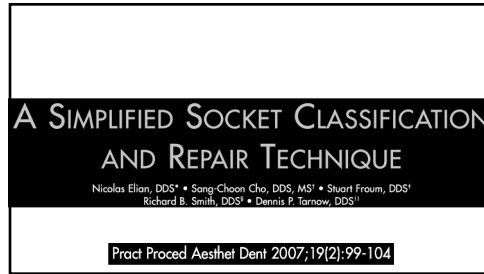
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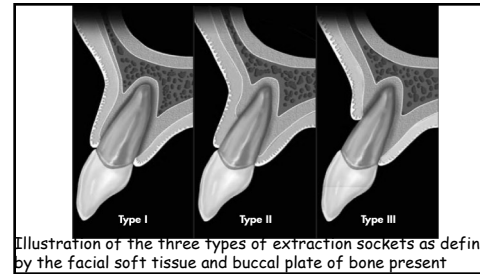
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14

What are Our Treatment Options?

15

**Autogenous Bone Graft**  
 Differences in autogenous bone form; eg. cortical/cancellous bone particulate, block graft

Depending on the configuration of the defect, alternatives to autogenous bone may be considered (Klein & Al-Nawas, 2011)

16

**Horizontal Defects**  
 Established treatment modalities include:  
 1. Autogenous bone  
 2. Bone expansion/ridge splitting  
 3. Guided bone regeneration (GBR)

17

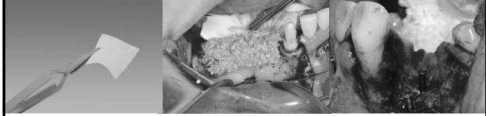
**Horizontal Defects**  
 GBR uses tissue barriers to separate hard tissue to be regenerated from overlying CT (Dahlin, Lindhe et al 1988; Dahlin, Sennerby et al 1989)

GBR has shown results comparable to autologous bone (von Arx, Cochrane et al 2001; Araujo, Sonohara et al 2002)

18

**Horizontal Defects**

Resorbable membranes need to maintain longer absorption time in the case of larger volume sites compared to non resorbable membranes




Adding autogenous bone chips to the augmentation material is recommended to improve the osteogenic potential

19

**Vertical Defects**

More demanding than treating strictly horizontal defects:




↑ Difficulty of soft tissue management      Need to stabilize the augmentation material (Tinti, Parma-Benfenati et al 1996)

20

**Vertical Defects**

Established treatment modalities include:

1. Autogenous bone blocks
2. Ti reinforced dPTFE membrane

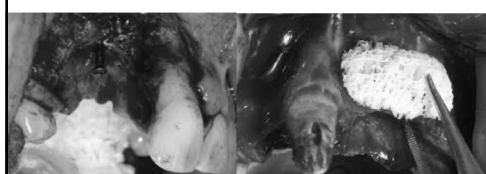


21

**Vertical Defects**

Established treatment modalities include:

3. "Tent pole" technique
4. Allogenic bone blocks and fixation screws

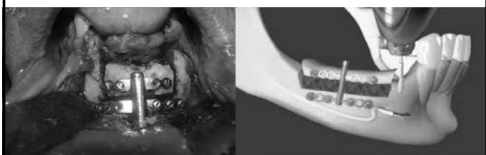


22

**Vertical Defects**

Established treatment modalities include:

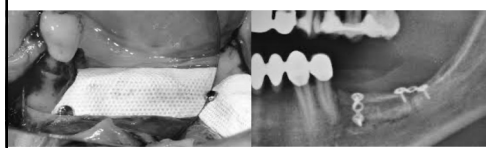
5. Distraction osteogenesis which also has the advantage of inducing soft tissue histogenesis (Hidding, Lazar et al 1999; Chiapasco, Lang et al 2006)



23

**Vertical Defects**

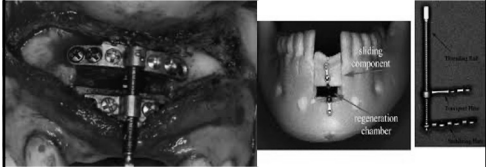
Onlay technique: osteoconductive bone substitute/autologous bone and non-absorbable membrane Canullo, Trisi et al 2006)



"Sandwich" technique: where bone formation is supported from both crestal & basal bone matrix after horizontal split osteotomy (Smiler, 2000; Jensen, 2006)

24

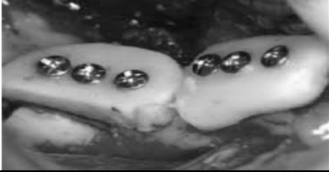
**Combined Defects**  
 Treatment follows the more exacting aspect of the defect



Consider distraction osteogenesis, however very challenging


25

**Combined Defects**  
 Extensive horizontal & vertical bone resorption often requires autologous bone grafts since there is inadequate osteogenic potential for use of bone substitute materials



26

**Sinus Defects**



High success rate for treating defects by sinus floor elevation

Internal osteotomy expansion technique

Lateral sinus wall approach for minor & extensive defects

27

**Summary**

- These recommendations serve as a general guideline in cases of healthy soft tissue and good general health conditions
- Future therapies will consider autologous stem cells and recombinant growth factors thus reducing the need for autologous bone harvesting

28

**Keys to Successful Bone Grafting**

29

**What Factors Affect Alveolar Resorption?**

- Anatomical differences between the anterior and posterior regions of the mouth
- Effect of periodontal disease on overlying labial/buccal process and lingual process
- Dehiscence of labial/buccal plate due to tooth eruption, orthodontic therapy, parafunction, trauma, vertical root fracture and extraction

30

## What Happens Following Tooth Extraction?

31

### What Happens Following Tooth Extraction?

- Most bone loss after extraction occurs in the first 6 to 24 months




Human re-entry studies showed horizontal bone loss of 29-63% and vertical bone loss of 11-22% after 6 months following tooth extraction.

Rapid reductions in the first 3-6 months that was followed by gradual reductions in dimensions thereafter

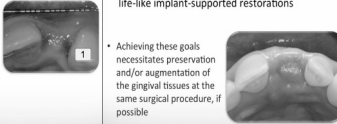
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32

### What Happens Following Tooth Extraction?

#### Preservation of Alveolar Bone

- 55% of sockets allowed to heal with blood clot alone required subsequent or simultaneous bone augmentation for implant placement, compared to fewer of the test sites



Patients expect implant survival and look for life-like implant-supported restorations

- Achieving these goals necessitates preservation and/or augmentation of the gingival tissues at the same surgical procedure, if possible

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33

### Site Development Through Ridge Preservation

#### Classification system for recommendations for augmentation (Salama, H. and Salama, M. 1993)

#### Type I extraction socket - all bone and soft tissue is preserved

Treatment: (I) bone graft and membrane

(II) bone graft alone

(III) membrane alone

(IV) heal naturally with blood clot (thick biotype\*)

34

### Site Development Through Ridge Preservation

#### Classification system for recommendations for augmentation (Salama, H. and Salama, M. 1993)

#### Type II extraction socket - extraction socket with a facial defect such as a dehiscence or a fenestration

Treatment: (I) will require ridge augmentation procedure

(II) bone graft and membrane

35

### Site Development Through Ridge Preservation

#### Classification system for recommendations for augmentation (Salama, H. and Salama, M. 1993)

#### Type III extraction socket - has both a facial defect and an interproximal vertical defect

Treatment: (I) first orthodontic extrusion

(II) bone graft and membrane if needed

36

## Socket Healing: What Happens Following Tooth Extraction?

37

### Socket Healing

#### Following Extraction:

- Resorption of Alveolar Ridge
- Resorption is related to:
  - Trauma from extraction
  - Natural healing process
- Only partial bone fill of socket

38

### Healing of the Extraction Site

- Phase 1: Initial angiogenesis (formation of new blood vessels)
- Phase 2: Formation of new woven bone (osteoid)
- Phase 3: Bone growth (deposition of osteoid by osteoblasts)
- Phase 4: Remodeling and maturation of bone

Oliva Y., J. Oral Implant, 1993

39

Comparison of extraction with no bone replacement to grafting with the insertion of a mineralized allograft:

- Non-treated sites: average socket decreased in bucco-lingual width from 9.1 mm to 6.4 mm.
- Grafted sites: average loss of bucco-lingual dimension was only 1.2 mm.
- The difference between the alterations was statistically and clinically significant

Basella J, Greenwell H, Miller R, et al. J Perio. 2003;24(7):990-999.

40

### Alveolar ridge preservation. A systematic review

1. Tooth extraction results in a statistically significant horizontal and vertical resorption of the AR, as part of the natural remodelling
2. The magnitude of the horizontal shrinkage is more pronounced than the vertical
3. The resorption of the ridge cannot be totally prevented by ridge preservation
4. Dimensional changes of the ridge may be limited by some of the ridge preservation techniques

Hornbith & Mardas & Mazzomo & Needleman & Donos Clin Oral Invest (2013) 17:341-363

41

### What Happens Following Extraction?

#### NO GRAFT:

- Resorption of facial and lingual bone
- Resorption of alveolar crest
- Complete bone regeneration prevented
- Continued resorption over time

42

**What Happens Following Extraction?**

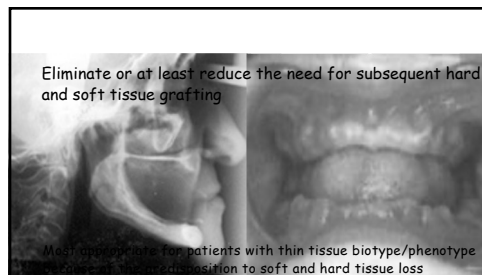
WITH GRAFT:

- Minimizes resorption of facial and lingual bone
- Minimizes resorption of alveolar crest
- Near complete bone regeneration is encouraged
- Improved maintenance of ridge height and width  
\*(physiologic resorption always exists)

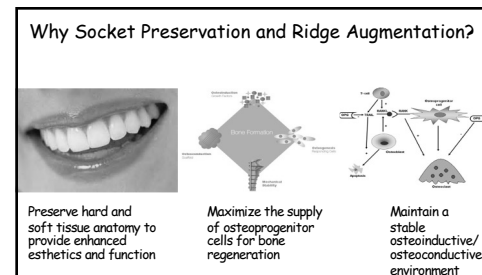
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**Clinical and Biologic Objectives for Ridge Preservation and Augmentation**

44



45



46

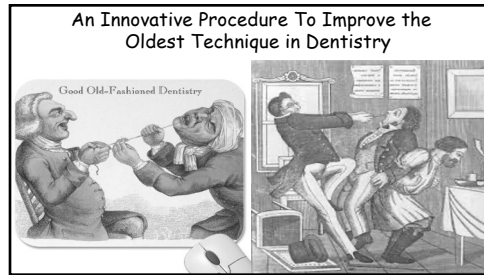
**What is the Prosthetic Treatment Plan?**

47

**What is Advanced Extraction Therapy?**

48





49

Advanced Extraction Therapy  
Examination of Clinical Data:

- What is the position of the tooth?
- Is there crown/root caries?
- How wide can patient open?

50

Advanced Extraction Therapy  
Examination of Clinical Data:

- Tongue and or cheek obstruction?
- Are the tissues healthy or is there periodontal disease?
- Are there any medical or psychological concerns?

51

Advanced Extraction Therapy  
Examination of Radiographic Data:

- Bone defects
- Abscess
- C/R ratio
- Furcation involvement
- Curved or Divergent roots

52

Bone Grafting

53

Bone Grafting

Indications:

- Replacement of missing dentition with a complete or removable partial denture ( a preserved or augmented ridge improves force distribution as well as mechanical support and retention )
- The pontic site for a fixed bridge is improved for esthetics, function and phonetics when the ridge is preserved or augmented
- A preserved or augmented ridge provides more predictable implant placement with ↑ vertical and horizontal dimension

54

### Bone Grafting

Indications:

- Regardless of the prosthetic/restorative treatment plan, it is better to have more than less bone present
- In the case of a patient who is undecided regarding the type of preferred tooth replacement at the time of extraction(s), there is still a benefit to socket preservation and/or augmentation for future replacement

55

### Bone Cells and Physiology

56

### What's Needed to Regenerate Tissue?

Cells: Differentiated (osteoblasts) or Undifferentiated (mesenchymal cells)

Matrix: Scaffold for cells to attach to and regenerate new bone

Signaling Molecules: Bone Morphogenetic Proteins (BMP's) which trigger undifferentiated cells into osteoblasts





57

### What are the Three Mechanisms of Action in Bone Formation?

- Osteogenesis:
  - Bone regeneration by the surviving cells
- Osteoid
- Osteoinduction:
  - Proteins and growth factors within the graft material stimulate undifferentiated cells at the host site to become osteoblasts and begin forming bone
- Osteoconduction:
  - Bone graft materials acting as a "scaffold" or "matrix" for new bone to grow onto and into the spaces

58

### Types of Bone

|   |   |
|---|---|
|   | Same Human  |
| Autograft: "Autogenous Bone" holy grail/gold standard |                      |
| Allograft: Human Donor Bone                           | Different Humans<br> |
| Xenograft: Bovine /Porcine Bone                       | Man : Animal<br>     |
| Alloplast: Synthetic                                  | Man : Synthetic<br>  |

59

### Demineralized Bone Products

DFDBA: Demineralized Freeze Dried Bone Allograft

- Type-I Collagen
- Exposed BMPs (Bone Morphogenetic Proteins)
- HCL bath removes the calcium phosphate

60

### Mineralized Bone Products

#### FDBA - Freeze Dried Bone Allograft

- Mineralized
- BMPs not exposed
- Calcium Phosphate retained - acts as a scaffold for cellular invasion

61

### Clinical Usage: Powders & Granules

- Choosing between demineralized and mineralized is still the clinician's choice
- Common sense suggests:
  - Standalone Application:
    - Mineralized: provides scaffold + collagen
  - Graft extender Application:
    - Demineralized: adds Type I collagen and BMP's to an existing scaffold without adding significantly more scaffold

62

### Alloplasts (Synthetic)

Man-made, synthetic graft materials consisting of calcium, acrylic, or glass. Also graft materials derived from other substances like coral

- Calcium-like materials: Include Osteograft/LD (hydroxyapatite), Osteogen (amorphous tricalcium phosphate), Capset (calcium sulphate), and HA powders



63

### How Are Different Types of Defects Classified?

64

### What Type of Graft Material do I Use?

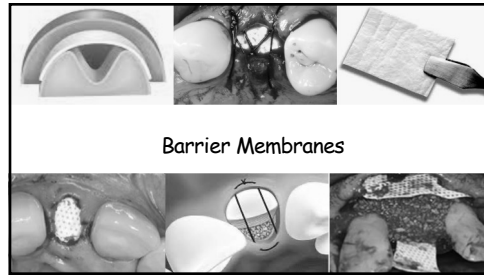
- 5 wall defect - allograft (DFDBA or FDBA), xenograft, alloplast and membrane or membrane alone
- 4 wall defect - allograft (DFDBA or FDBA), xenograft, alloplast and membrane

65

### What Type of Graft Material do I Use?

- 2 or 3 wall defect (periodontal) - autogenous bone chips, DFDBA, FDBA (C/C mix) or growth factors (PDGF, PRF, CGF) plus particulate bone graft, e.g., "sticky bone"
- 1 wall defect - autogenous bone block or blend of DFDBA and calcium phosphate or FDBA (C/C mix), resorbable or non-resorbable membrane; depending on size of defect: tacks and /or bone screws

66



67

### Barrier Membrane Types

|   |  |
|---|--|
| <p><b>Resorbable:</b></p> <ul style="list-style-type: none"> <li>▪ Synthetic polymers                     <ul style="list-style-type: none"> <li>• Lactide/glycolide</li> <li>• Polylactic acid blended with citric acid ester</li> </ul> </li> <li>▪ Natural biomaterials                     <ul style="list-style-type: none"> <li>• Collagen, e.g., bovine, porcine</li> <li>• Amnion/chorion/trophoblast membrane</li> </ul> </li> </ul> | <p><b>Non-Resorbable:</b></p> <ul style="list-style-type: none"> <li>▪ e-P TFE (expanded Polytetrafluoroethylene) 1<sup>st</sup> GEN, e.g., Gore-Tex</li> <li>▪ d-PTFE (non-porous Polytetrafluoroethylene) 2<sup>nd</sup> GEN, e.g., Cytoplast d-PTFE</li> <li>▪ Titanium mesh</li> </ul> |
|---|--|

68

### Barrier Membrane Types

|                       |  |
|-----------------------|--|
| <p>Non-resorbable</p> |  |
| <p>Resorbable</p>     |  |

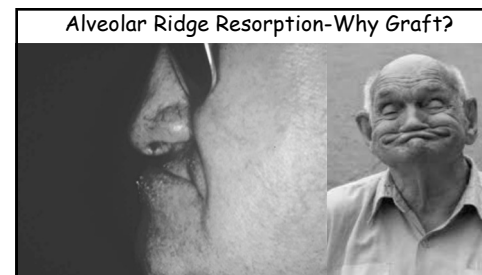
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What are the two types of bony defects that require the use of a membrane?

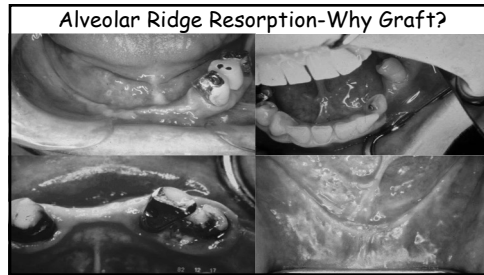
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### Alveolar Ridge Preservation Why and How To Graft

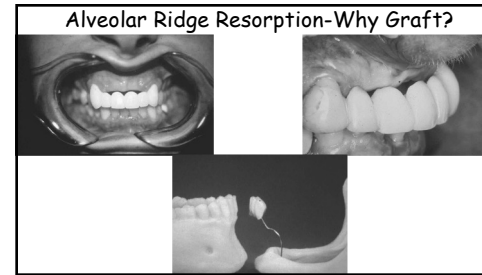
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72



73



74

Alveolar Ridge Preservation  
How?

75

- Alveolar Ridge Resorption: How?
- Site preparation:
    - (1) Degranulate
    - (2) Decorticate
  - Place the graft - don't pack material
  - Close:
    - Primary & passive closure (if possible)
    - Membrane - when indicated

76

Socket/Alveolar Ridge Preservation  
How To Graft/Surgical Technique

77

- Patient Consultation  
Discuss Immediate Advantages
- Significantly less bleeding
  - Reduced risk of infection
  - Less chance for a dry socket

78

**Patient Consultation**  
**Discuss Immediate Advantages**

- Ridge preservation
- Better fitting prosthesis
- Easier and better oral hygiene
- Esthetics

79

**Review of Protocol**

- (1) Atraumatic extraction
- (2) Prepare the site:
  - Degranulate - must remove ALL diseased tissue
  - Decorticate - MUST have marrow bleeding
- (3) Place the graft - don't pack material (AVOID condensing the graft material!)
- (4) Closure:
  - Primary & passive closure (when possible) otherwise....
  - Membrane - must be stabilized (non-resorbable membrane may need bone tacks/screws)

80



81