BACHELOR OF DENTAL SURGERY

Periodontal healing and Guided Tissue Regeneration

DCP 4 Semester 2

Dr.Betul Rahman

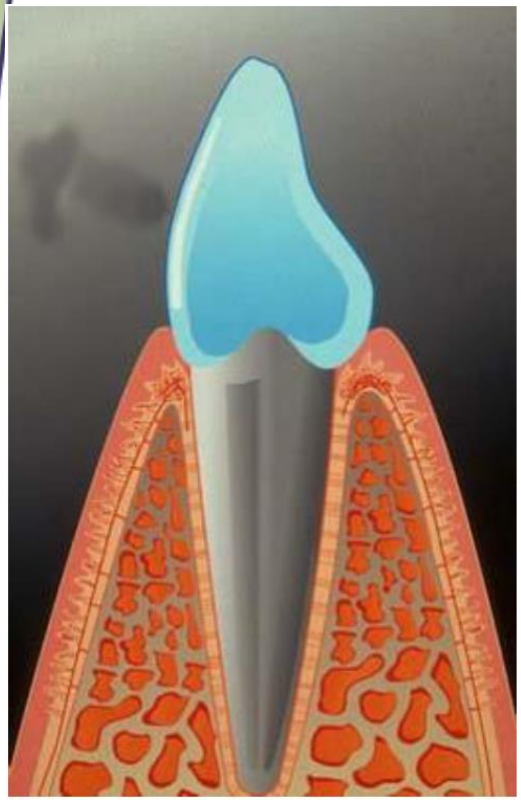
Learning Outcomes

At the end of this lecture, Students

1.should know the range of periodontal healing responses after periodontal therapies

2.should understand the biological basis and the method of GTR and GBR

3.shoud know biochemical approaches to periodontal regeneration and role of periodontal osseous grafts and types of grafting materials in the treatment of bony defects



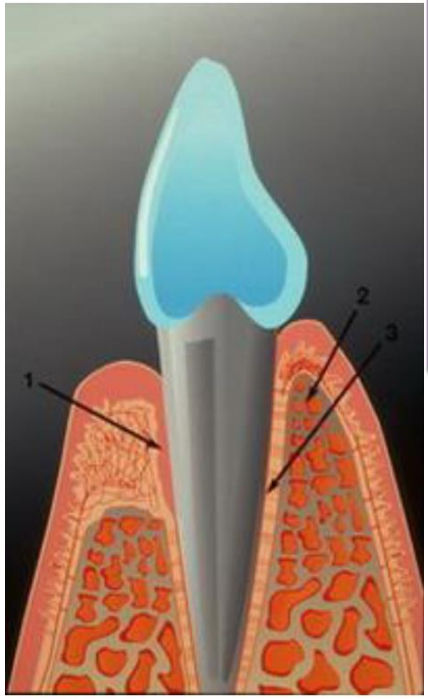
Healthy Periodontal Tissues

Periodontitis:
Tissues before Treatment

Range of periodontal healing responses

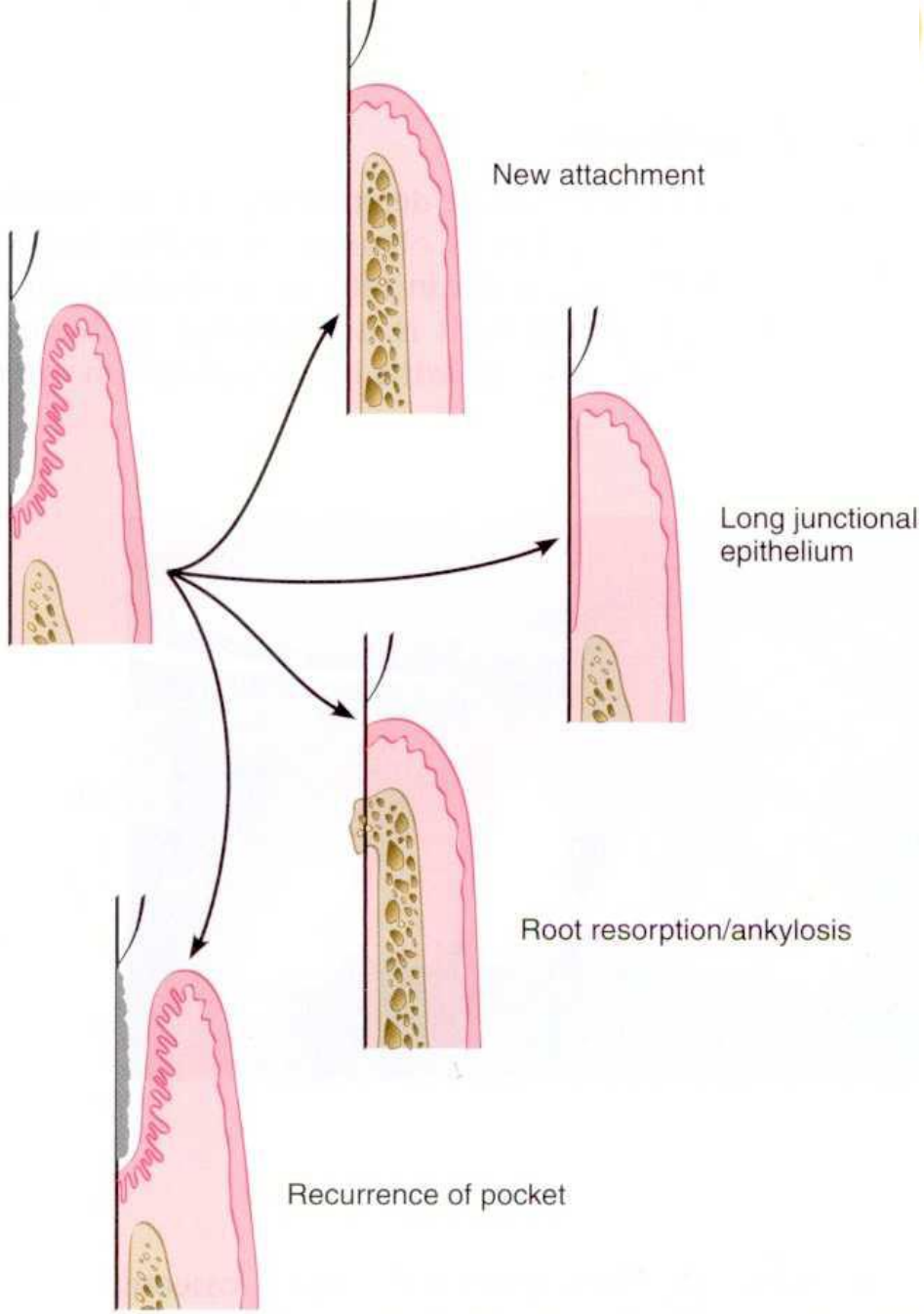
I. Healing with a long junctional epithelium, which can result even if filling of bone has occurred.

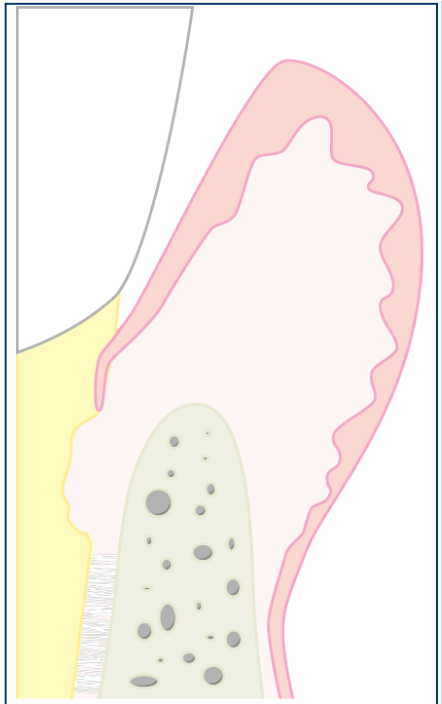
(**Long JE:** During the healing process, the tissues shrink, cells of the oral epithelium grow out and develop into a new JE which continues to grow apically until it reaches to CT fibers embedded in cementum.)



2. Ankylosis of bone and tooth with resultant root resorption.
3. Recession.
4. Recurrence of the pocket.
5. Any combination of these results.

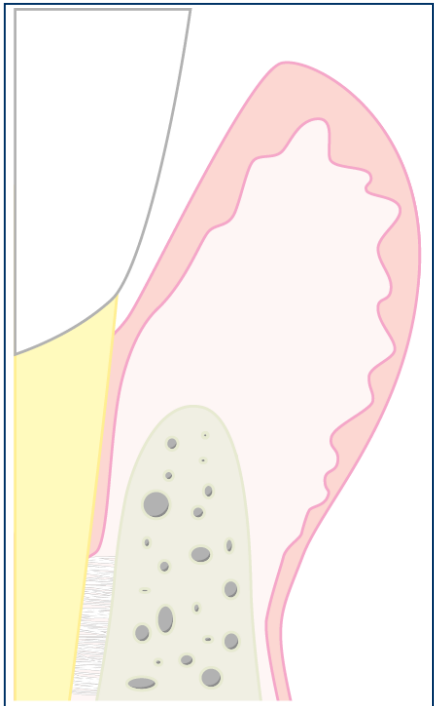
- Possible outcomes of reconstructive periodontal therapy.





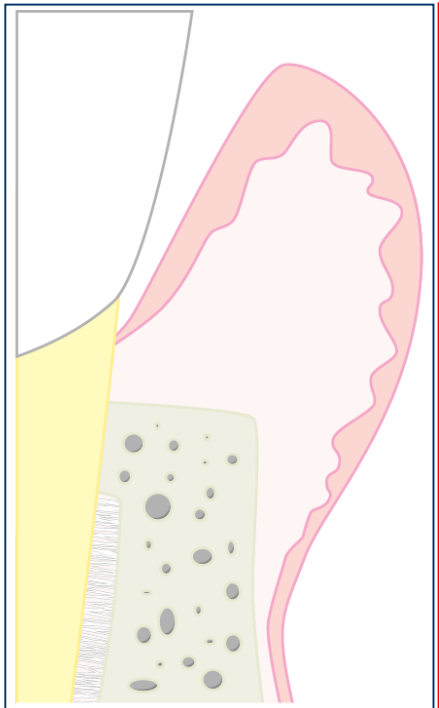
Gingival CT

Root resorption



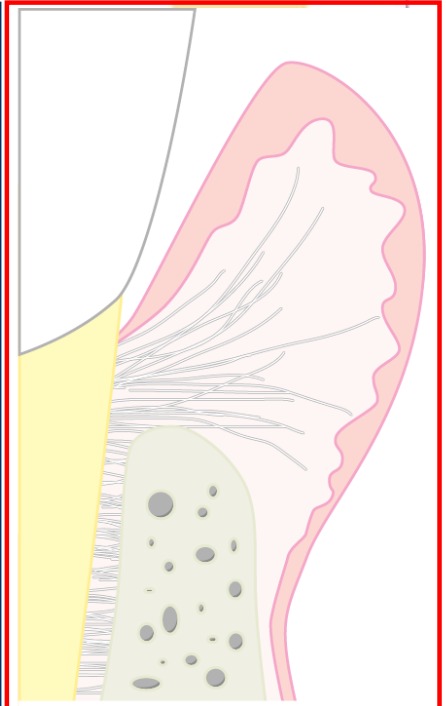
Epithelium

Long JE



Alveolar bone

ankylosis



PDL

Regeneration

In 1976, Melcher suggested in a review paper that the type of cell which repopulates the root surface after periodontal surgery determines the nature of the attachment that will form.

Re-attachment vs New attachment

- **Re-attachment:**

  Reunion of a root surface which still has PDL attached, with the surrounding tissues. For example, after tooth avulsion, PDL fibres on tooth surface reunite with bone, forming functional PDL.

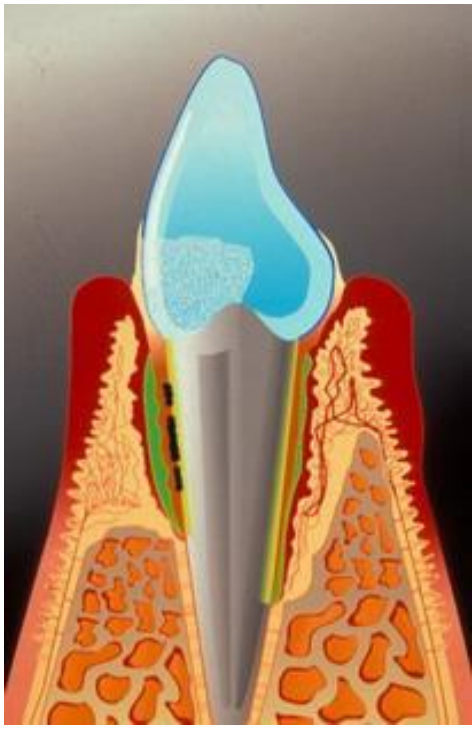
- **New attachment / true regeneration:**

  Formation of new cementum with inserting collagen fibres on a root surface that has been denuded of PDL.

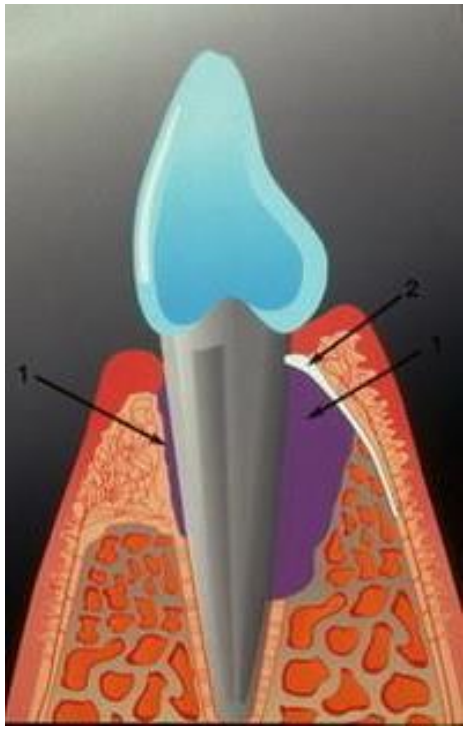
  Regeneration of the tooth supporting structures (cementum, ligament and bone) following loss of periodontal tissues due to periodontitis.

- The usual periodontal response to non-surgical treatment and conventional flap surgery is the formation of a long junctional epithelium. Occasionally, true regeneration occurs in the most apical 1-2 mm of the bony defect.

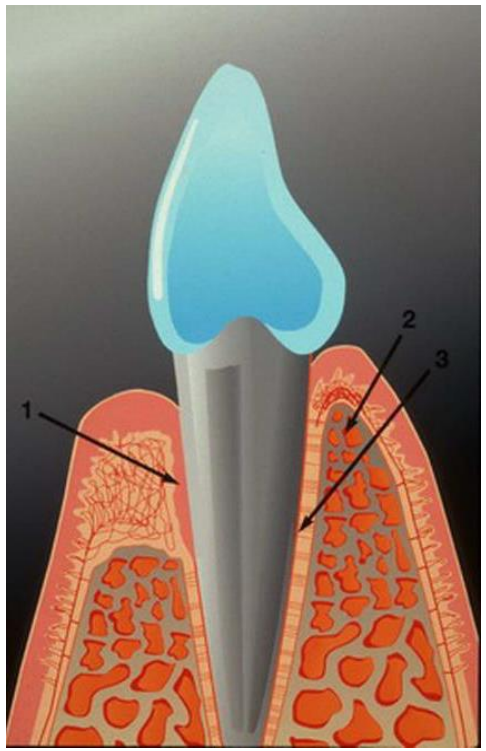
- New attachment with periodontal regeneration is the ideal outcome of therapy because it results in obliteration of the pocket and reconstruction of the periodontium.



Periodontitis



Tissues before healing



Tissues after healing

Reconstructive techniques:

- non–bone graft–associated
- bone graft-associated
- biological mediator–associated new attachment and regeneration.

In clinical practice, it is common for clinicians to combine these various approaches

Non–bone graft–associated:

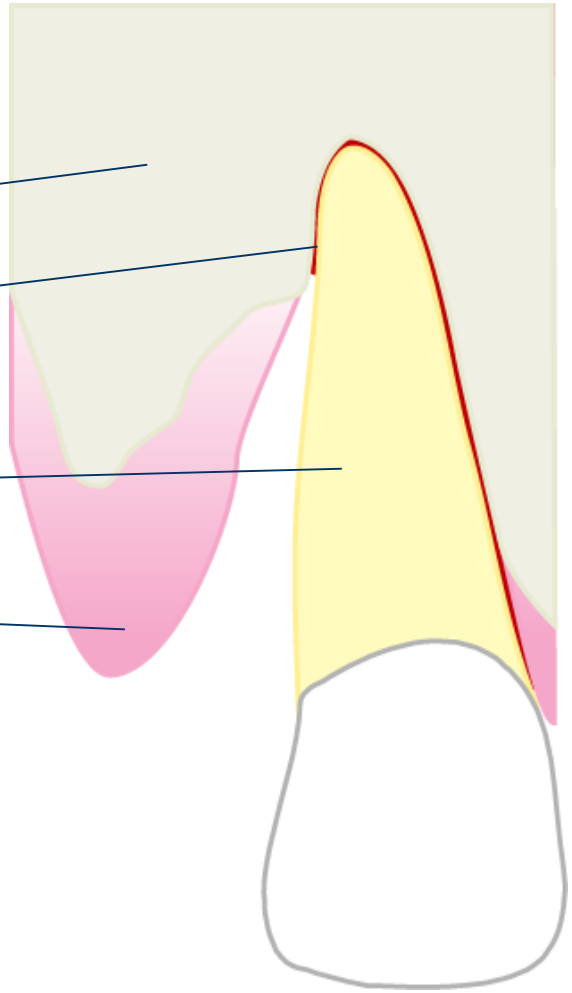
Guided Tissue Regeneration:

- The method for the prevention of epithelial migration along the cemental wall of the pocket and maintaining space for clot stabilization is a technique called *guided tissue regeneration* (GTR).

Guided Tissue Regeneration:

Periodontal lesion

- bone
- PDL
- root
- gingiva



Guided Tissue Regeneration:

- In GTR barriers(membranes) of different types are placed to cover the bone and periodontal ligament to temporarily separate them from the gingival epithelium.

- Excluding the epithelium and the gingival connective tissue from the root surface during the postsurgical healing phase:

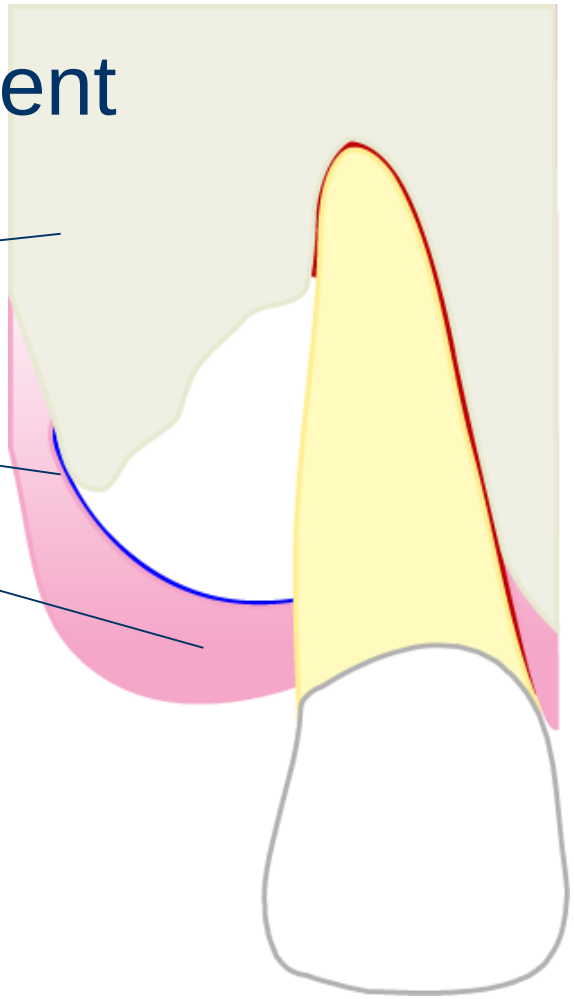
  -prevents epithelial migration into the wound,

  - favors repopulation of the area by cells from the periodontal ligament

Guided Tissue Regeneration

Barrier Membrane Placement

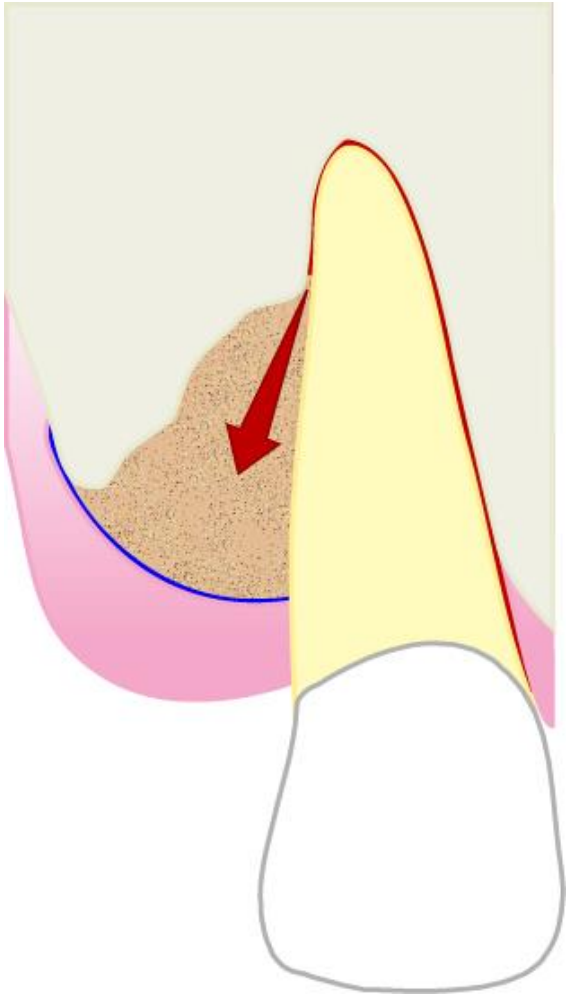
- bone
- GTR membrane
- gingival tissues (flap)



Guided Tissue Regeneration

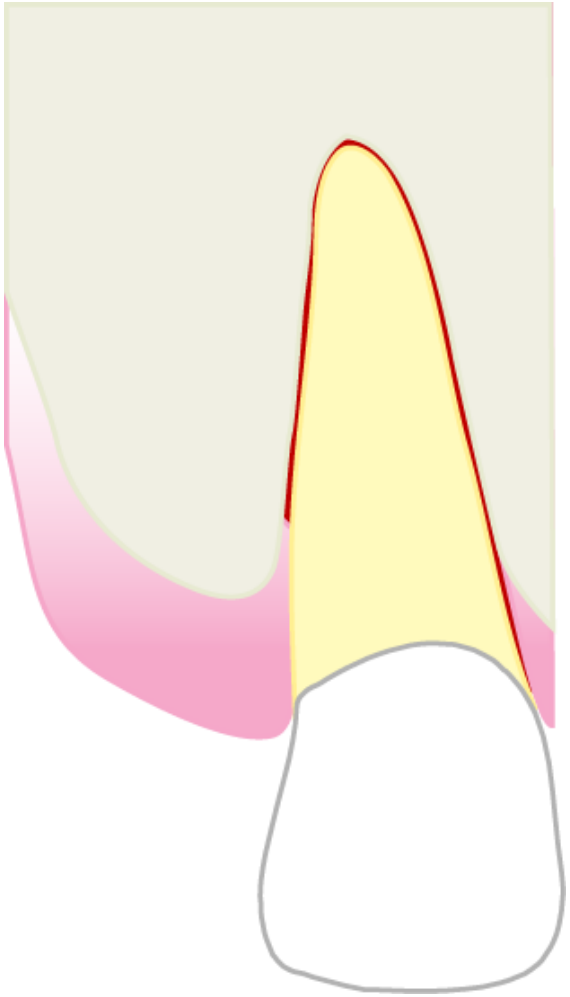
- In theory, stem cells from PDL populate the bony defect and differentiate into cells forming cementum, bone & ligament.

- **Epithelial cells are excluded**.



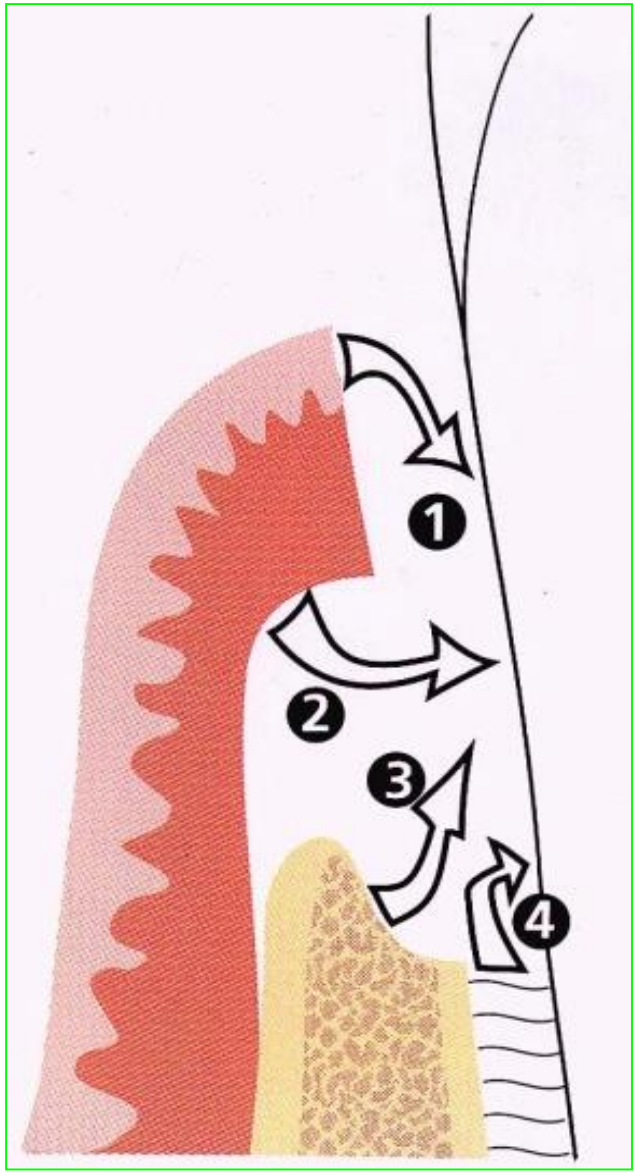
Guided Tissue Regeneration

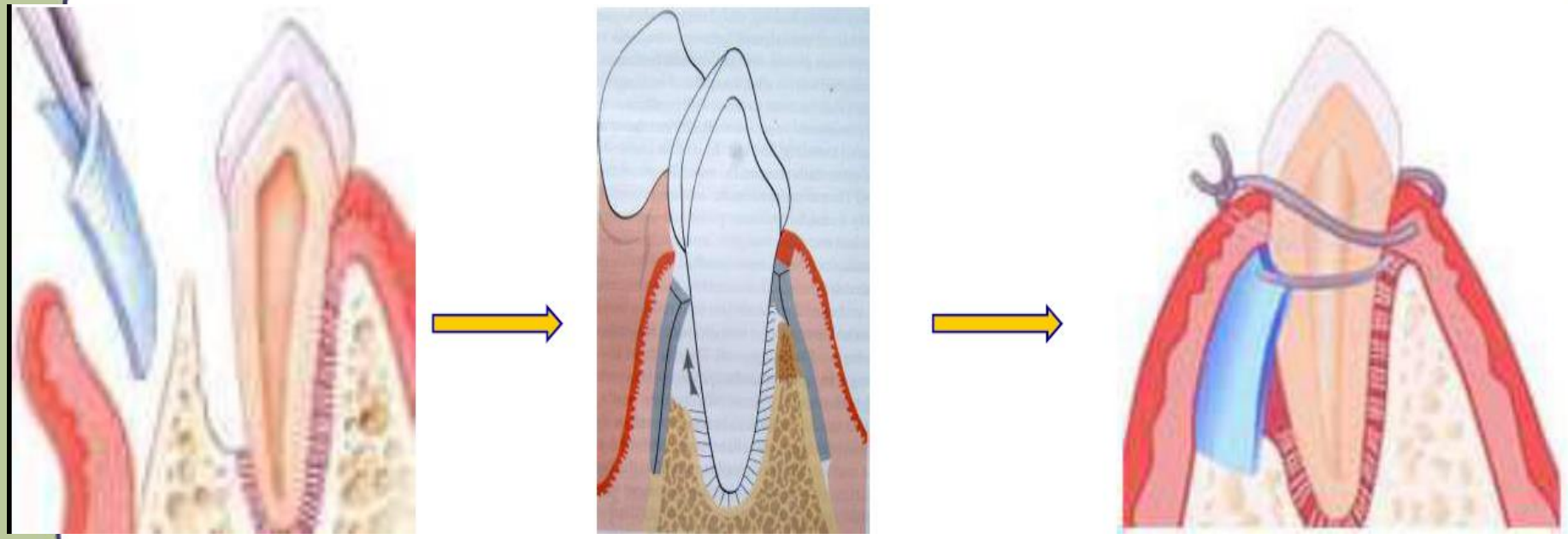
- In theory, periodontal tissues (ie bone, ligament & cementum) are regenerated after 3-6 months.
- The key to periodontal regeneration is the formation of new cementum & bone



- Epithelial and gingival connective tissue cells in relation to their inherent growth/migration rates

- Epithelial cells ➔hours to days
- Gingival CT cells ➔days to weeks
- PDL cells ➔ days to weeks
- Bone cells ➔ weeks to months





GTR Membranes

Non resorbable membranes:

- Millipore filters
- Teflon membranes
- polytetrafluoroethylene membranes (Gore-Tex periodontal material, G-Tam)

Resorbable (Biodegradable) Membranes:

- BioGuide (OsteoHealth), a bilayer porcine-derived collagen;
- Atrisorb (Block Drug),a polylactic acid gel;
- Biomend (Calcitech), a bovine Achilles tendon collagen that resorbs in 4 to 18 weeks.

BioGuide is easier to use and generally preferred.

Considerations in GTR

Defect Size & Topography

Defect Cause

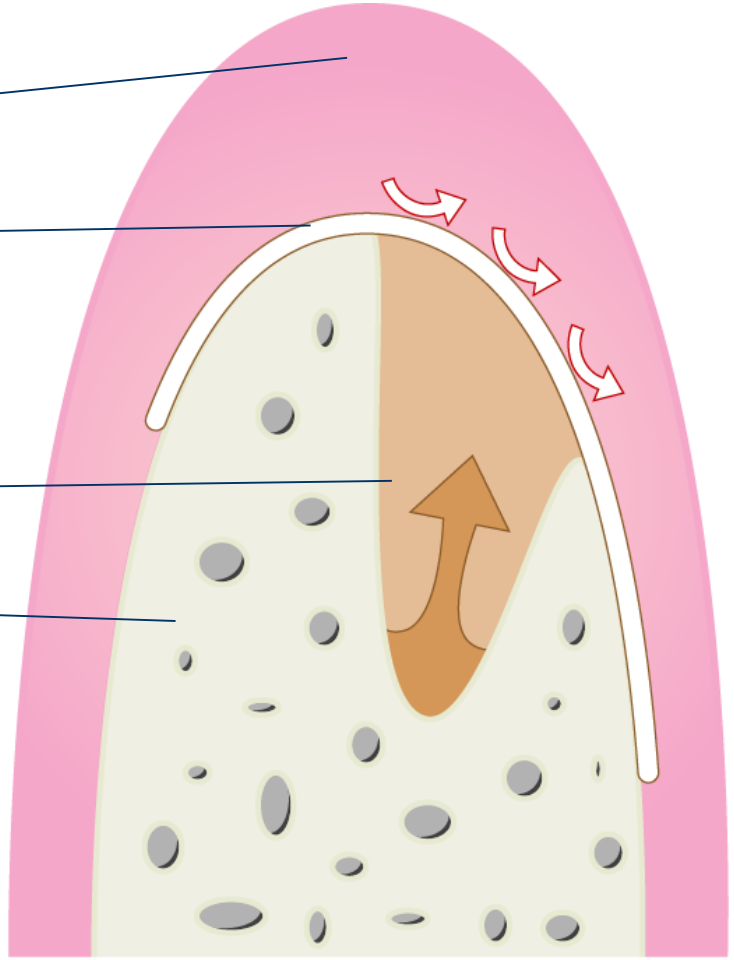
Technical difficulties

Predictability?

- GTR is not limited to periodontal uses. In fact, it is far more predictable when used for ridge augmentation (guided **bone** regeneration), implant recovery etc, because the underlying tissues are sealed from bacteria.

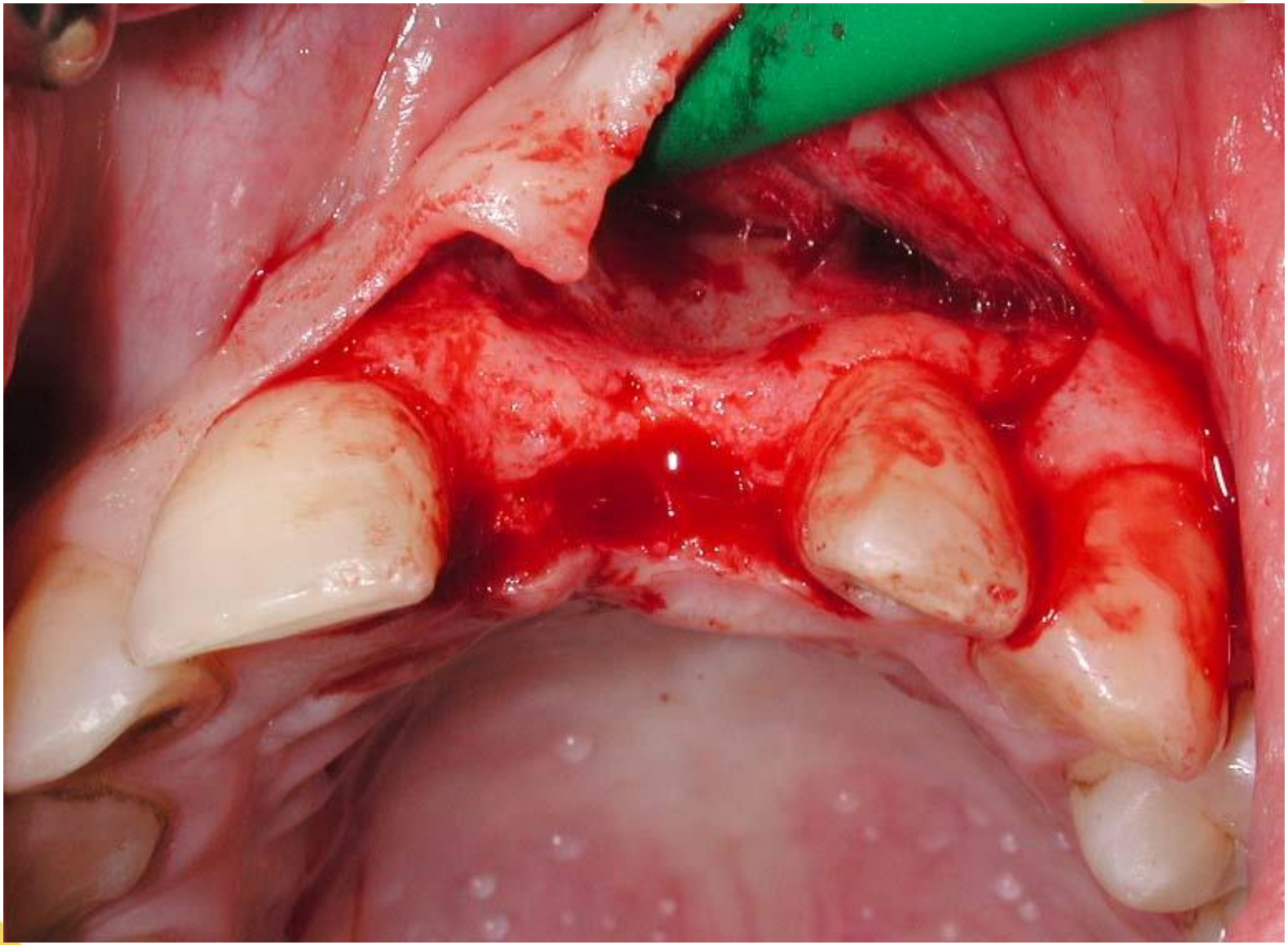
Guided Bone Regeneration (GBR)

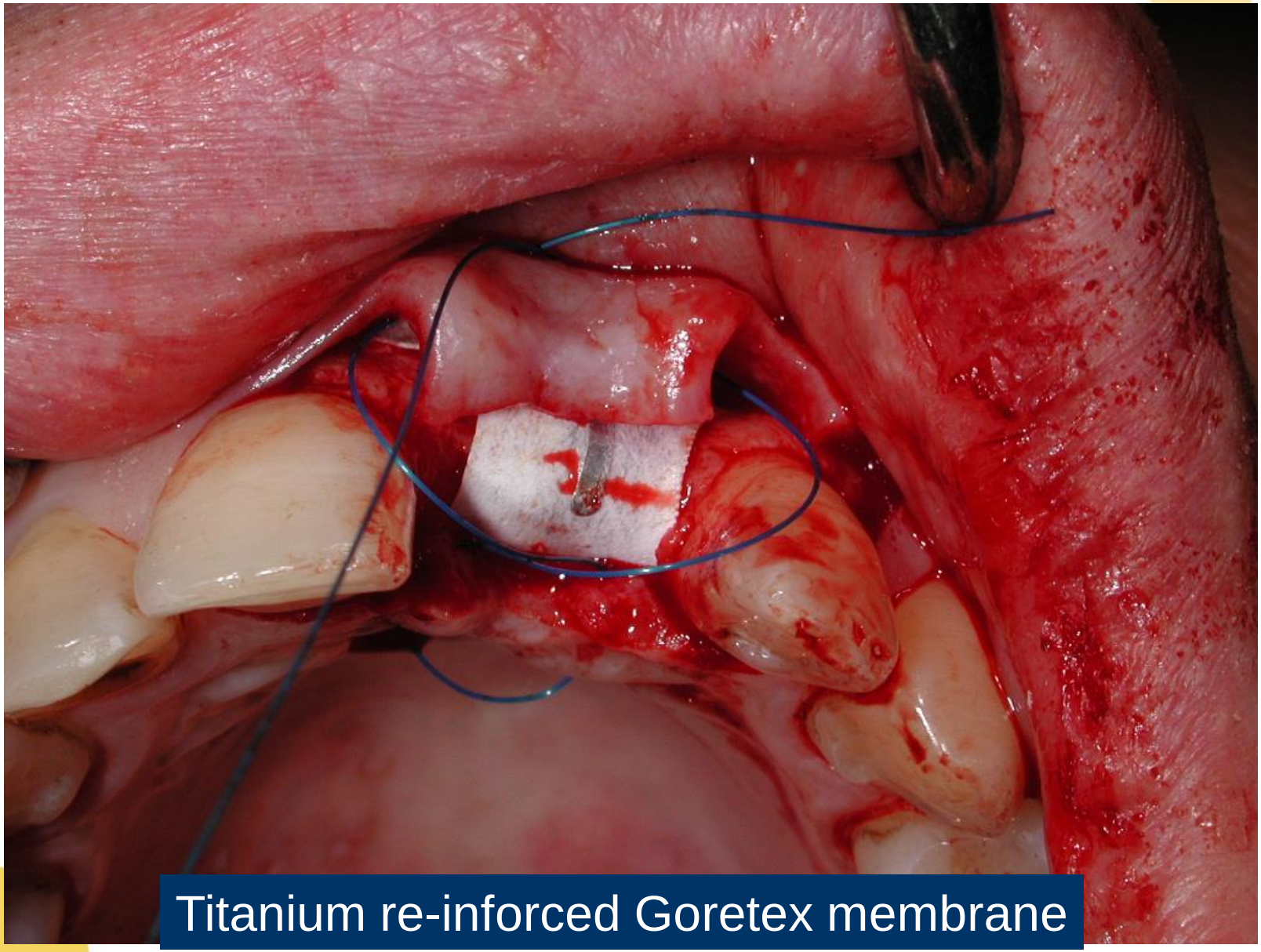
- gingiva
- membrane
  - prevents ingress of epithelial cells
- defect
- bone



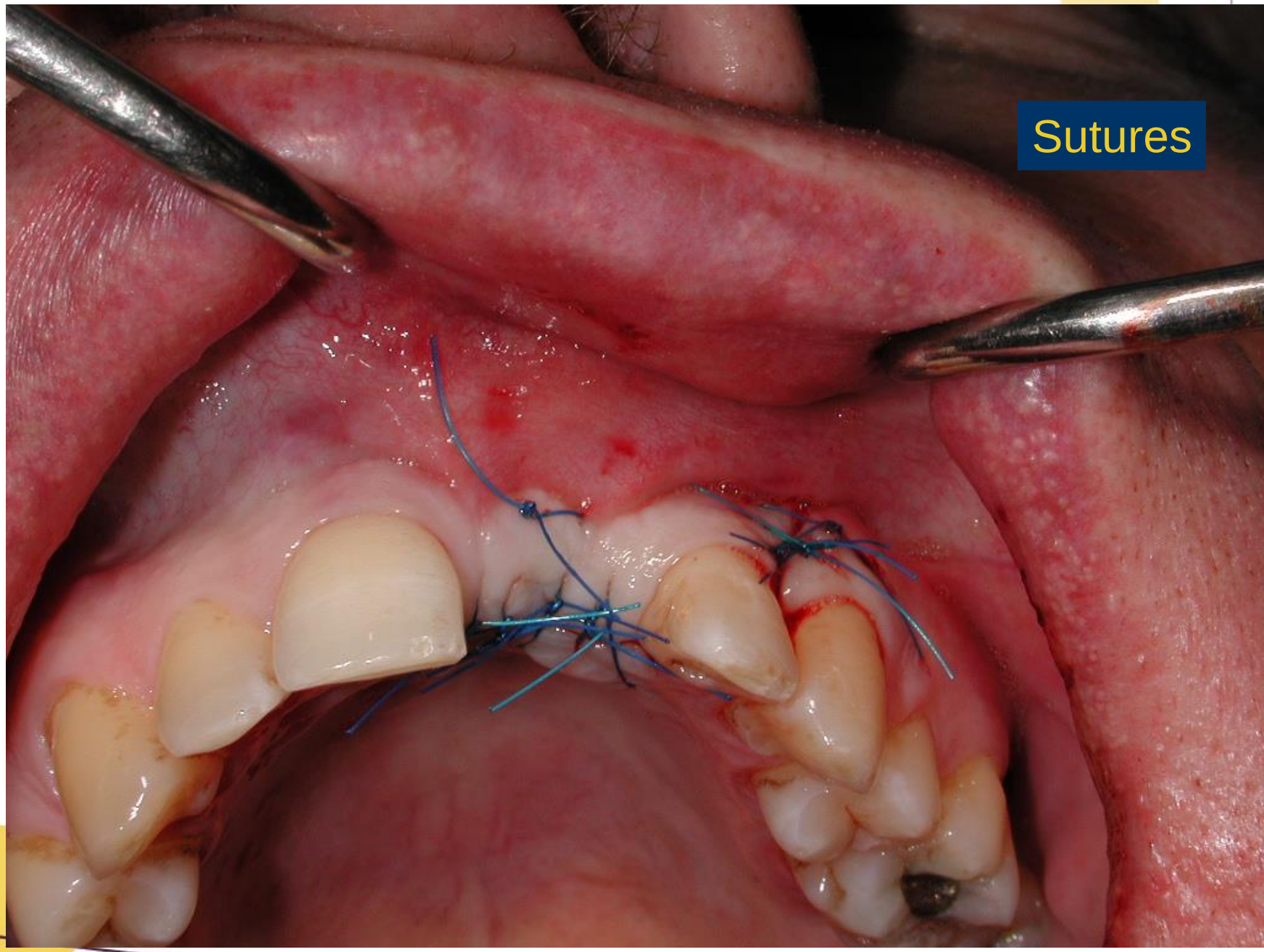
Guided Bone Regeneration (GBR)

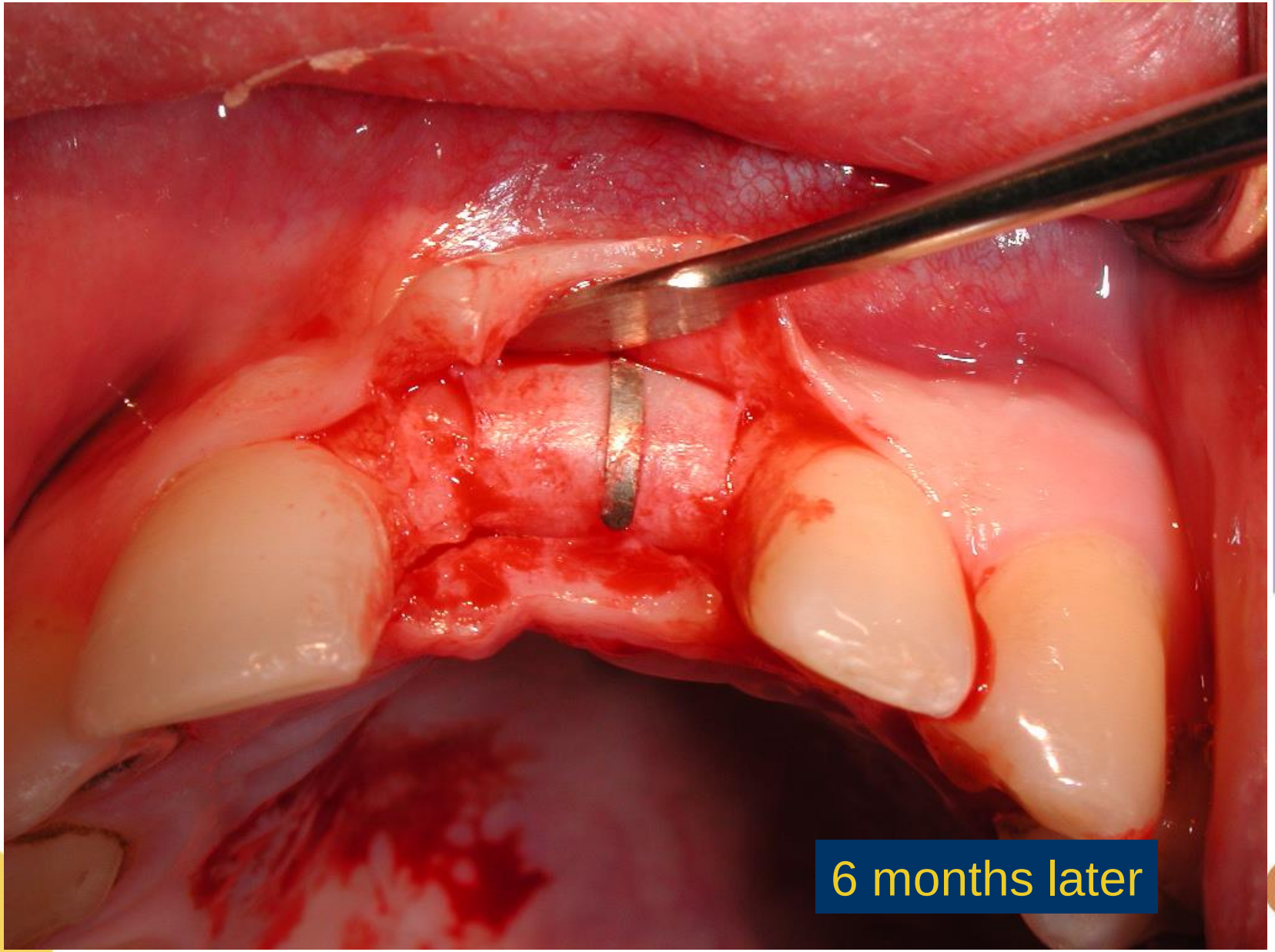
- only one type of tissue to form: bone
- much more predictable than GTR

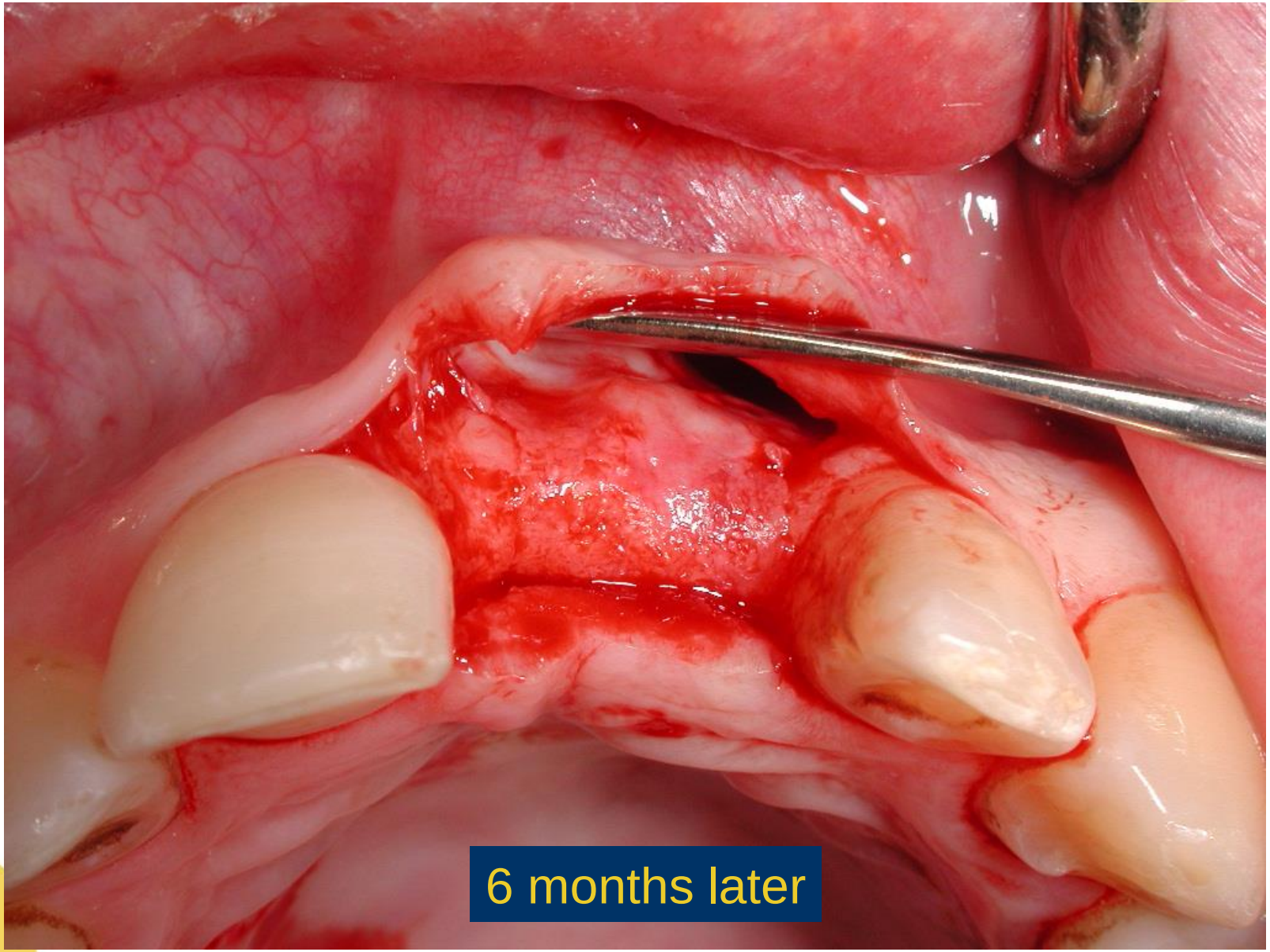




Titanium re-inforced Goretex membrane







Guided Tissue Regeneration

Watch video

Periodontal surgery

Bone Augmentation

Length 3.25 minutes

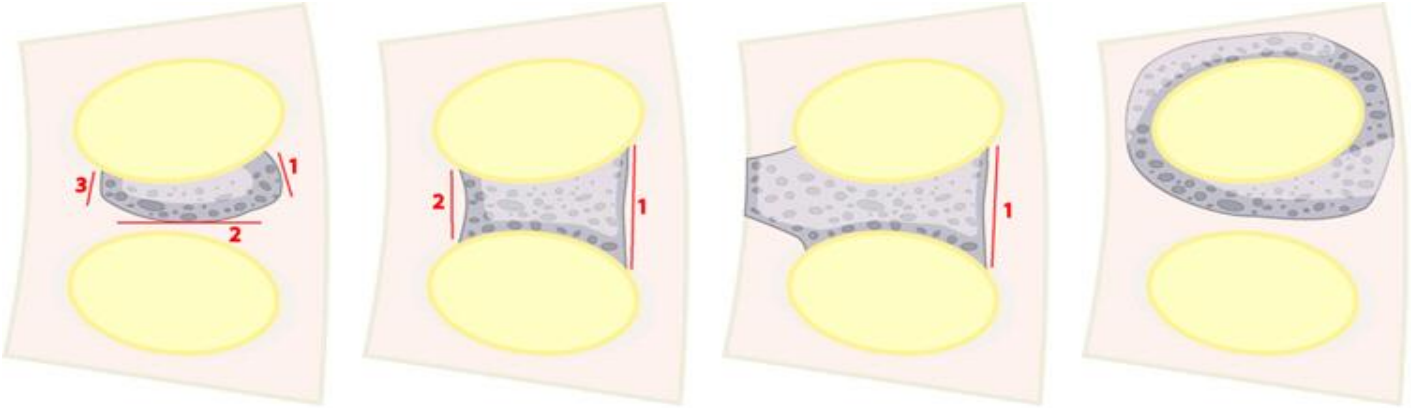
Dr Soukoulis and Dr Kardachi

Bone graft-associated Reconstructive Surgery:

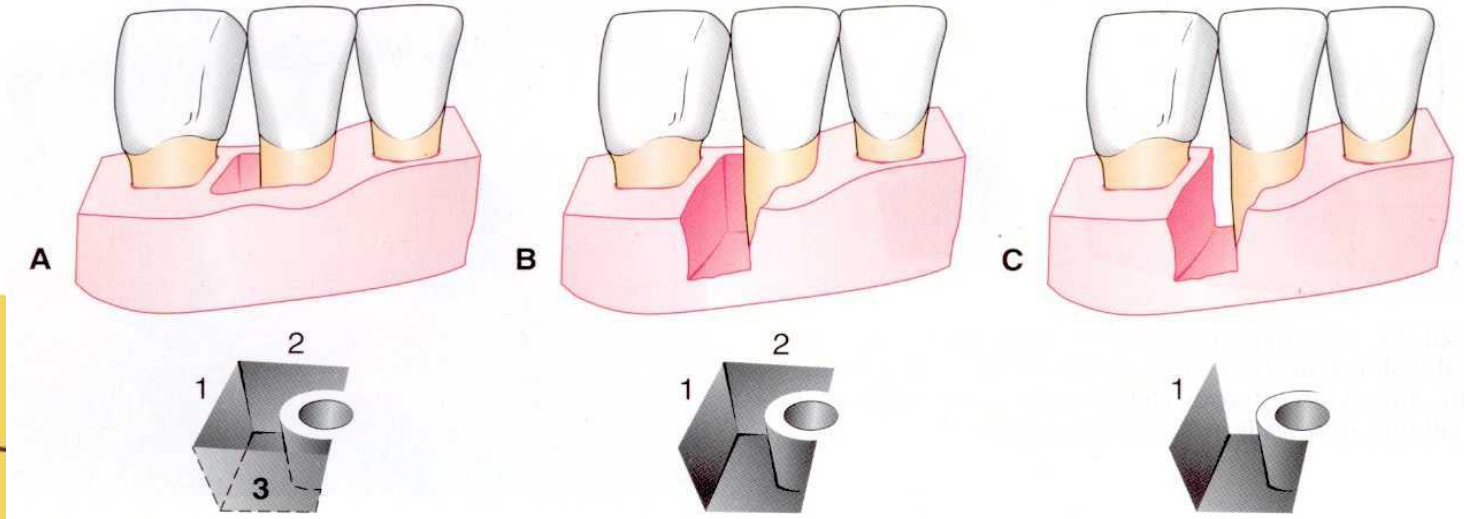
Periodontal osseous grafts:

Filling osseous defects with materials which encourage osteogenesis / periodontal regeneration.

Periodontal osseous grafts



3 wall bony defect | 2 wall bony defect | 1 wall bony defect | Crater/cup defect



Periodontal osseous grafts

- Bone graft materials are generally evaluated based on their osteogenic, osteoinductive or osteoconductive potential.
- **Osteogenesis:** Formation or development of new bone by cells contained in the graft.
- **Osteoinduction:** Chemical process by which molecules contained in the graft (bone morphogenetic proteins) convert the neighboring cells into osteoblasts, which in turn form bone.
- **Osteoconduction** is a physical effect by which the matrix of the graft forms a scaffold that favors outside cells to penetrate the graft and form new bone.

Periodontal osseous grafts

- Osseous grafts are used to fill in bony defects, usually in conjunction with guided tissue regeneration. **The effectiveness of grafting decreases as the number of osseous walls decreases.**
- The grafts are thought to act as a scaffold during organisation of the blood clot, allowing connective tissue cells to re-populate the wound. Currently, materials are being developed which are osteo-inductive and play an active role in regeneration.

Periodontal osseous grafts

Types of grafting materials

- Materials to be grafted can be obtained from the same individual (autografts), from a different individual of the same species (allografts),from a different species (xenografts), or non-bone grafts(alloplastic grafts)

- **Autogenous bone grafts:** harvested from intra oral sites or from iliac crests(extra oral)
- **Allograft:** decalcified freeze-dried bone **allograft** (DFDBA) derived from cadavers(same species)
- **Xenograft** : Bovine bone treated to remove all organic components. Fully biocompatible and sterile(Bio-oss)

Types of grafting materials(cont.)

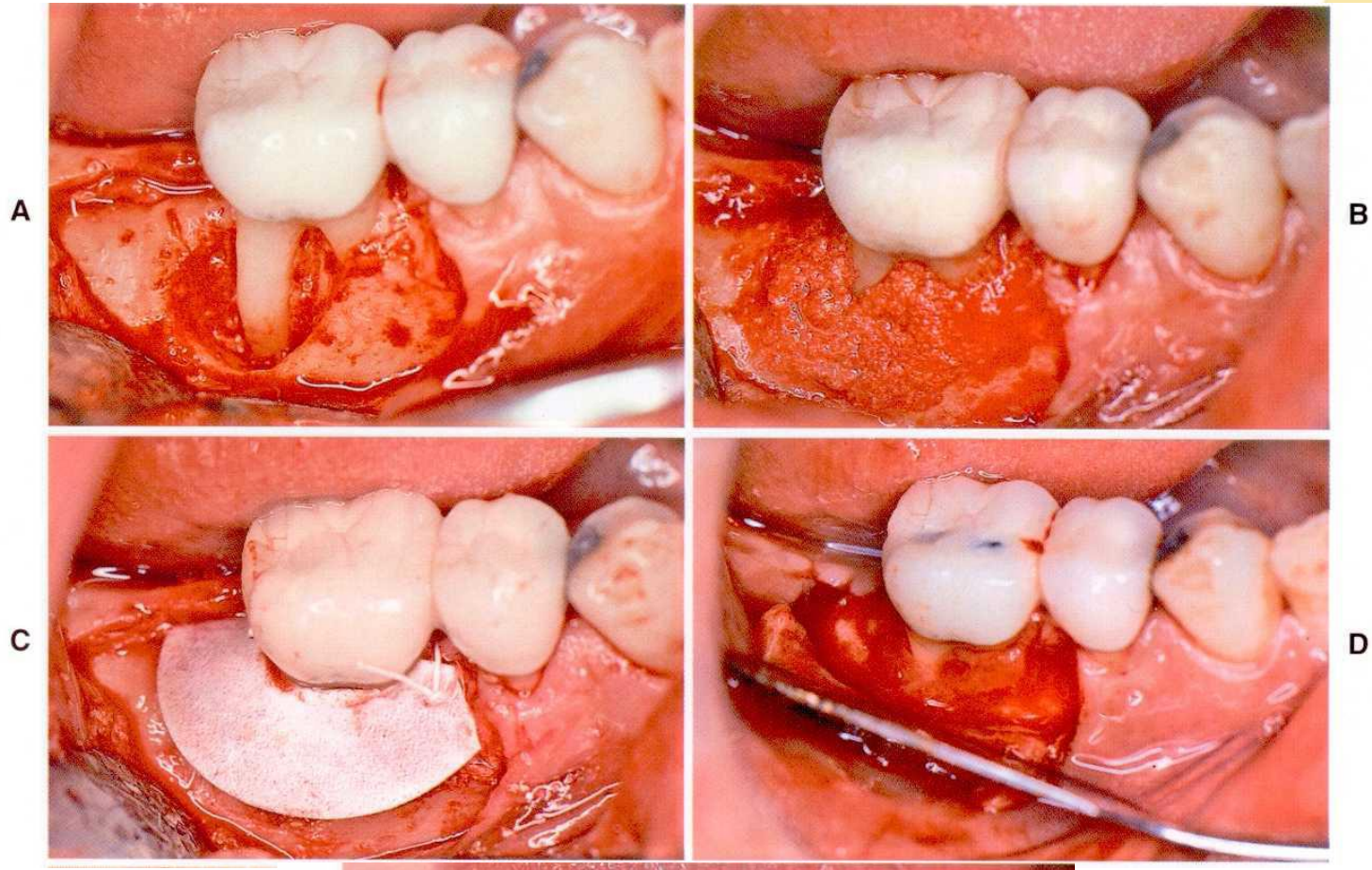
Alloplastic graft (non bone graft materials) resorbable tricalcium phosphate, biocoral, plaster of Paris. These materials acted as fillers only.

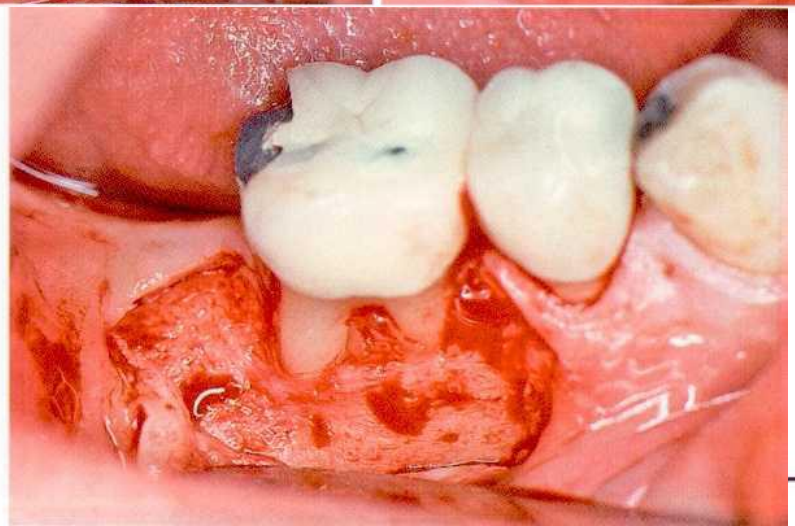
Bioactive glasses are a special compositional range of glasses and glass-ceramics that develop a mechanically strong bond to living tissues. Some of these glasses stimulate the osteogenic potential of bone by activating genes to produce growth factors.

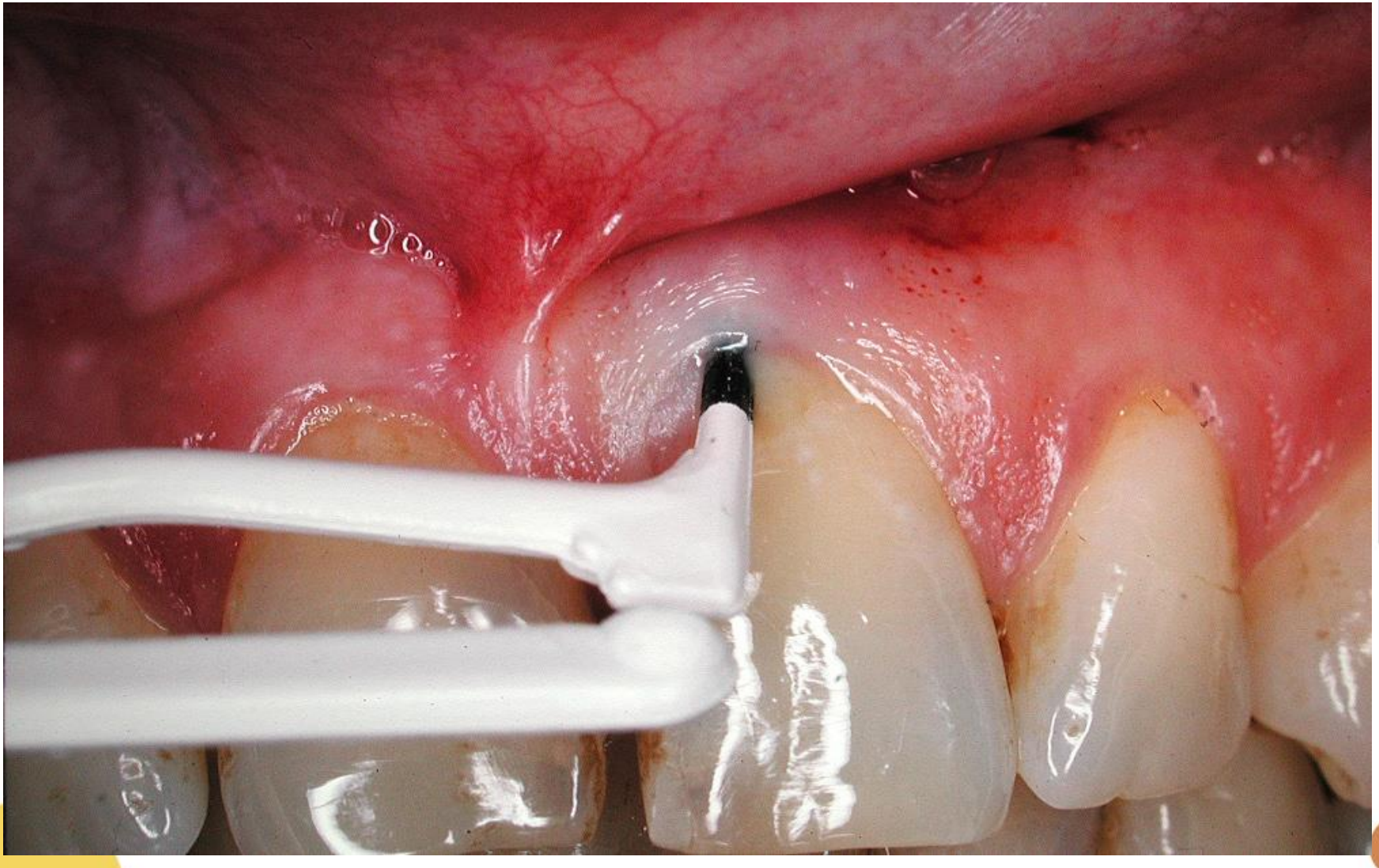
Periodontal osseous grafts

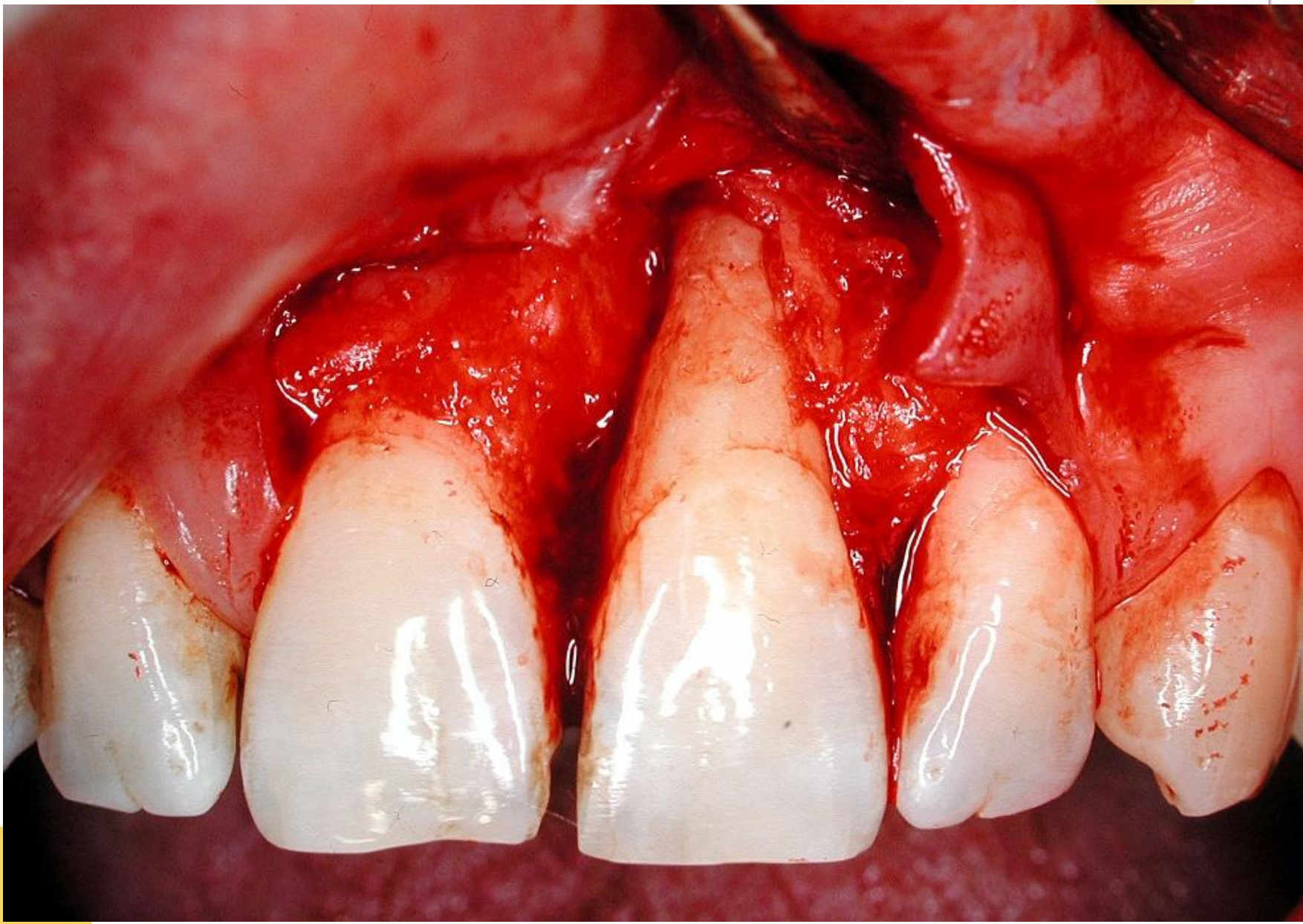
BIO-OSS

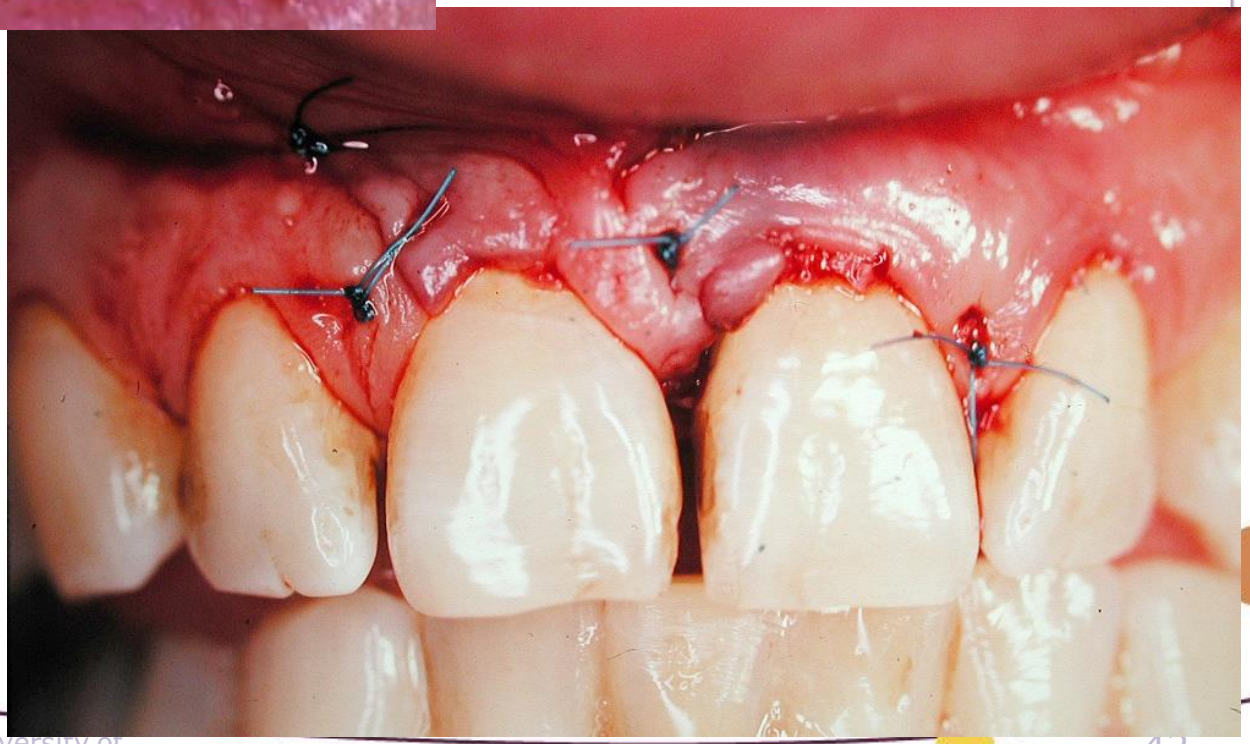
Watch video
Periodontal Surgery
Ridge Preservation
Length 10.24 minutes
Dr Soukoulis and Dr Kardachi









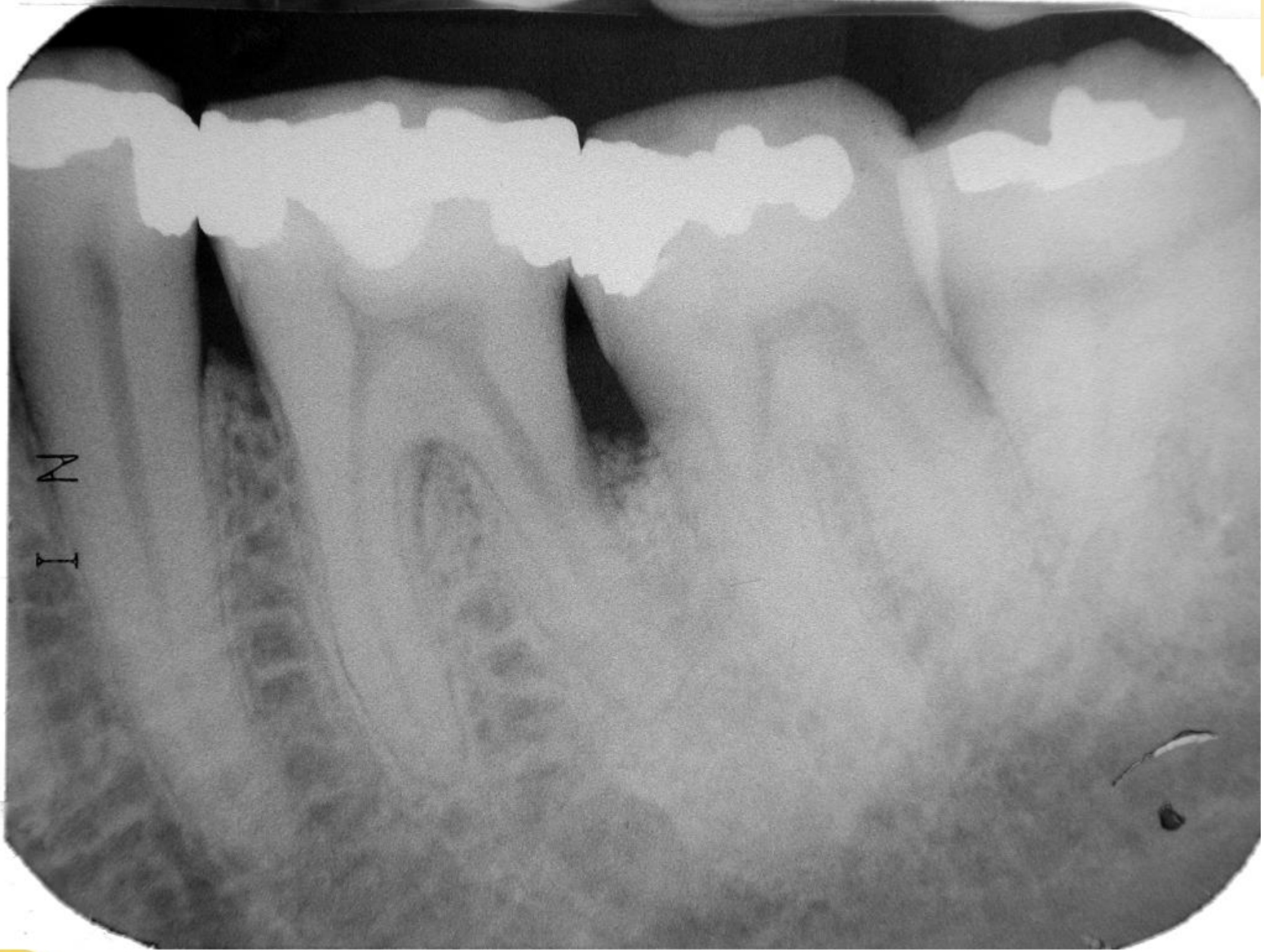


11 months after surgery

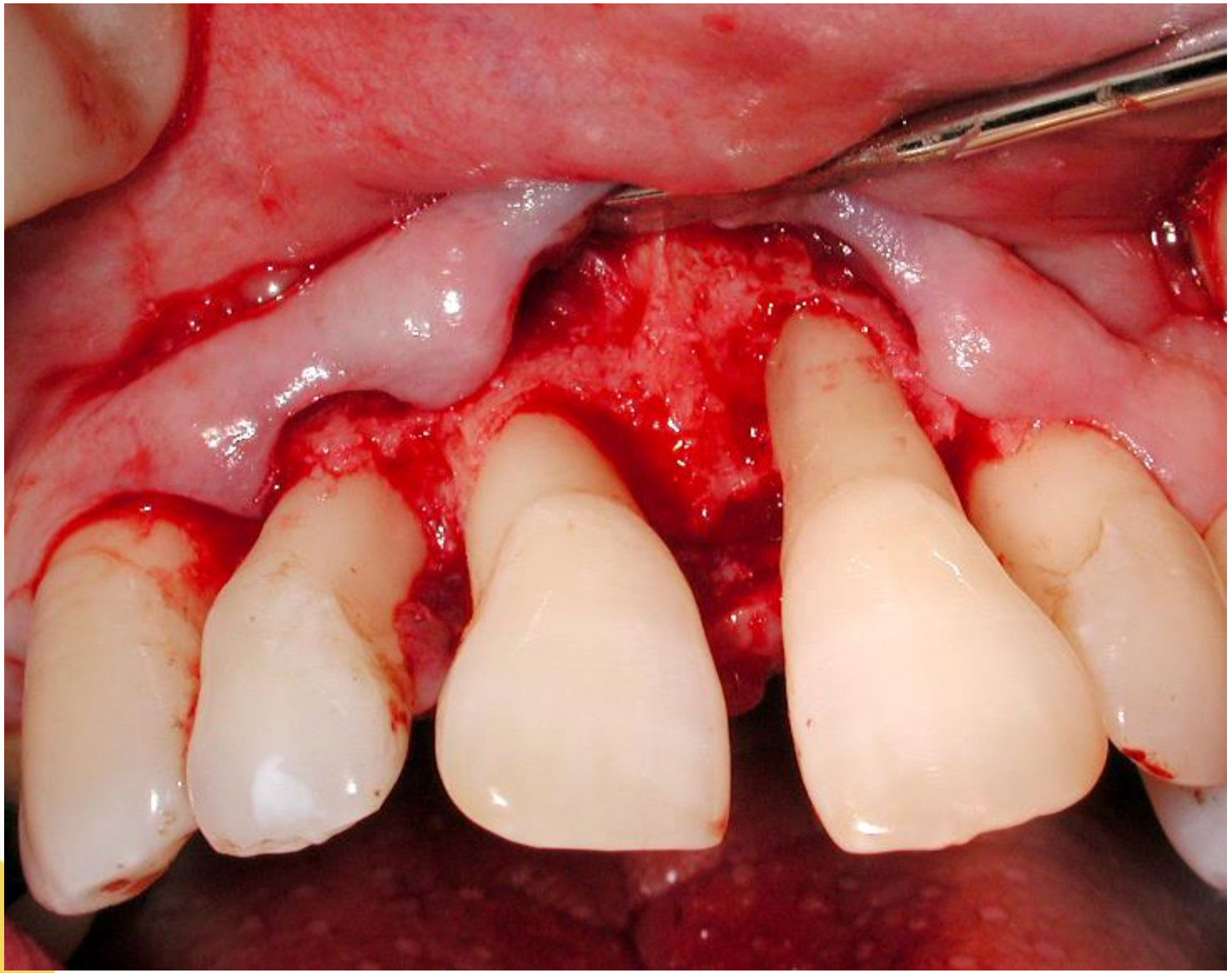
Bio-oss radiograph sequence

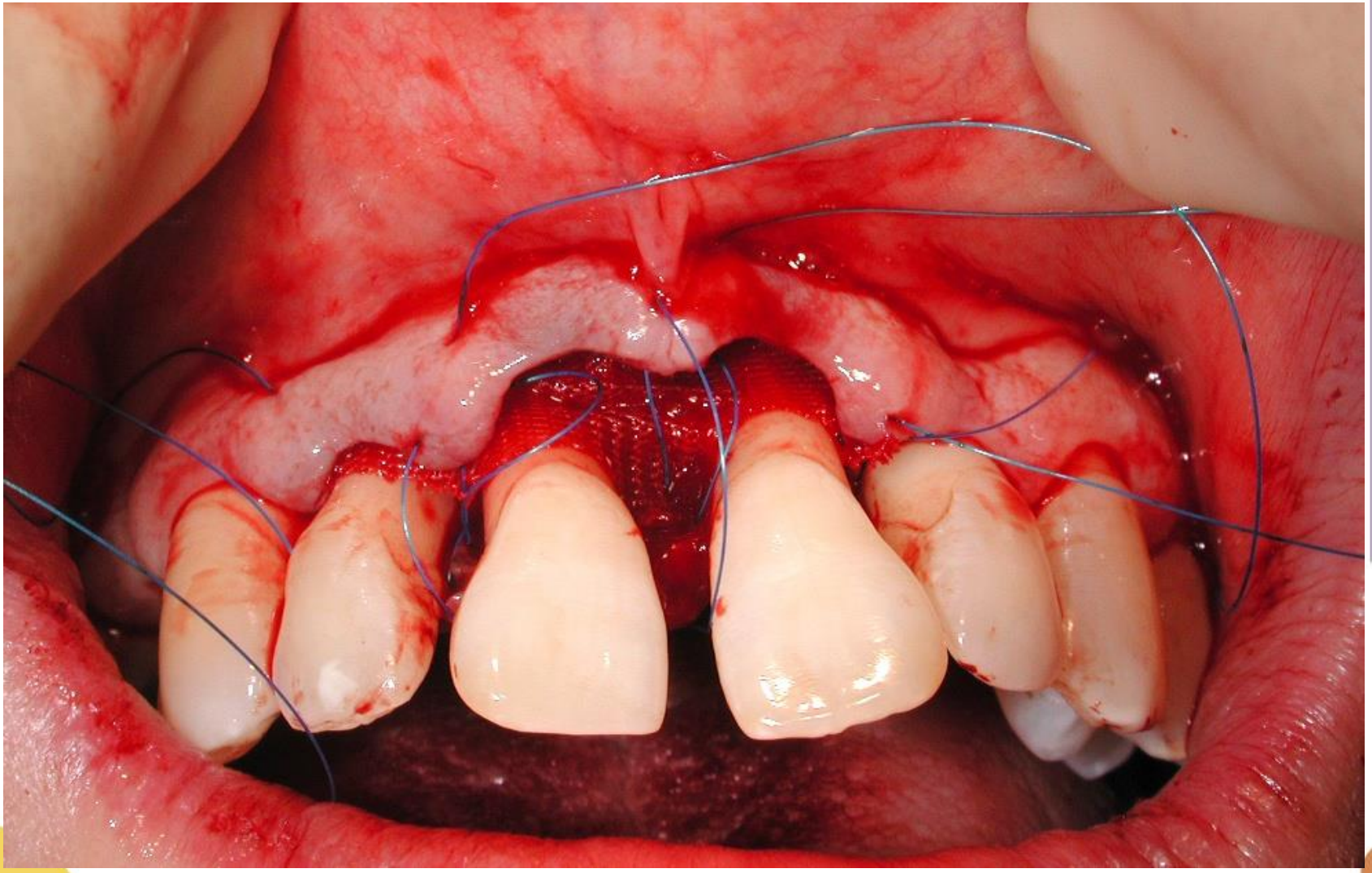
Immediately following surgery

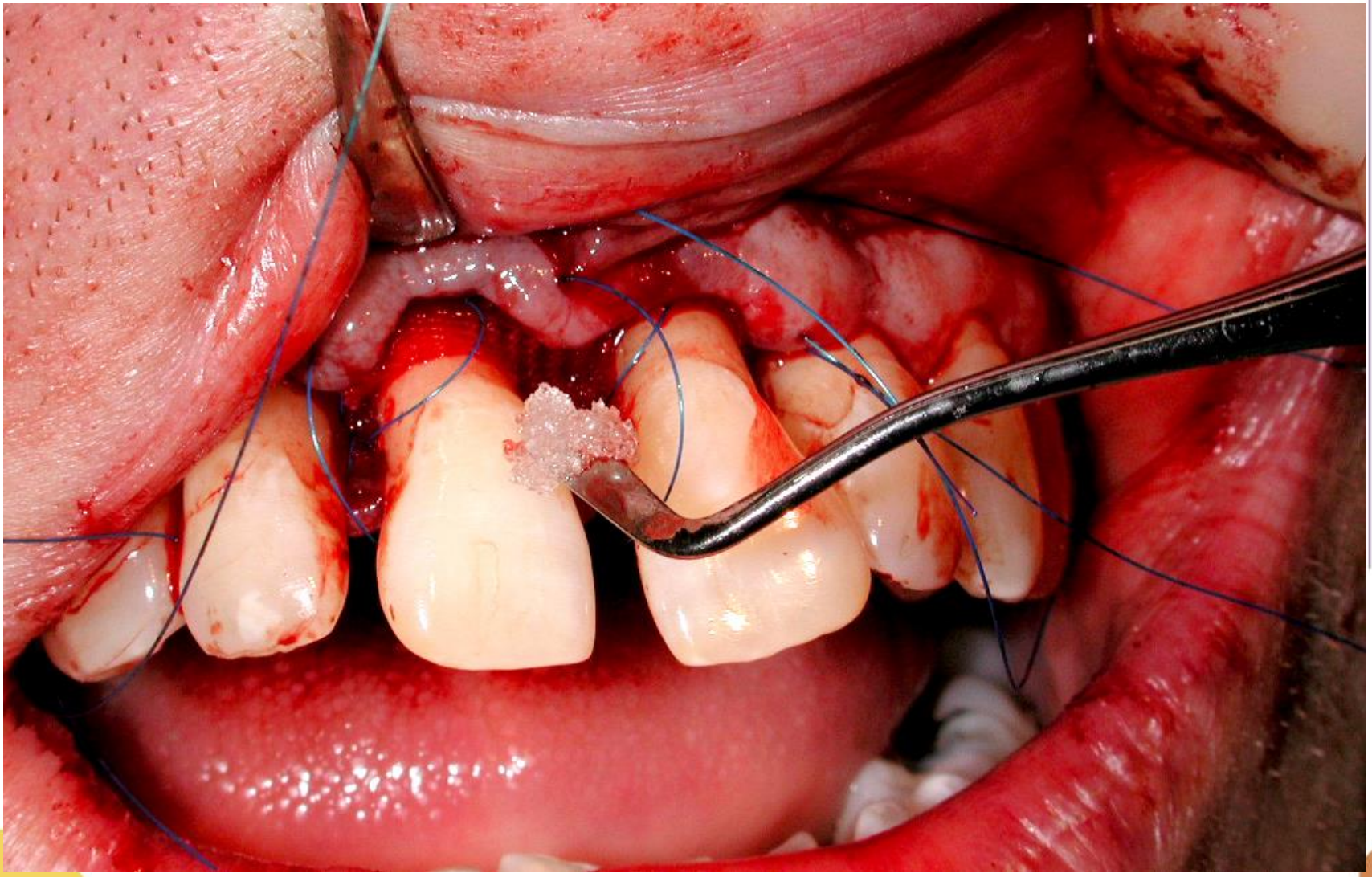
4 months following surgery

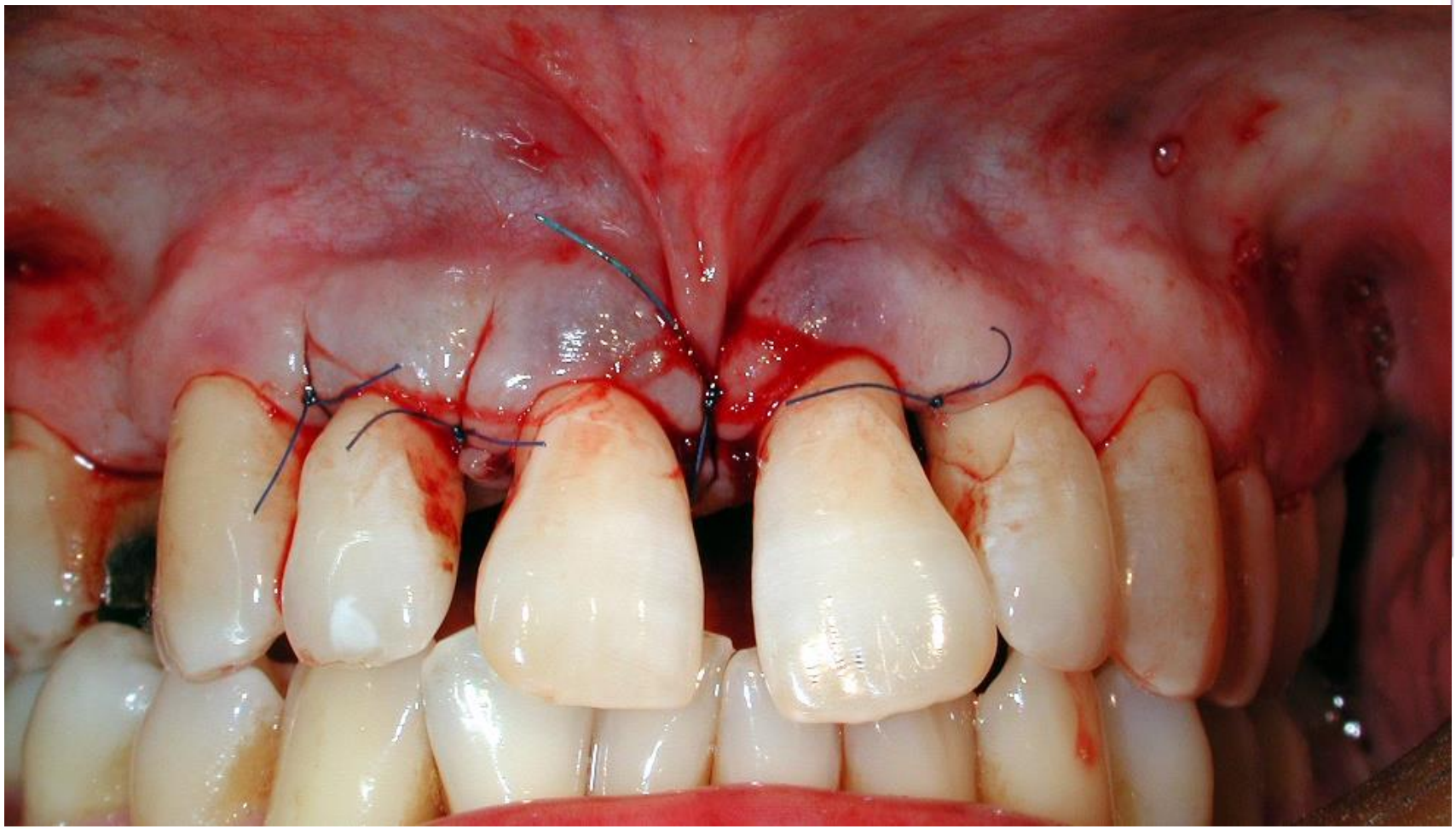


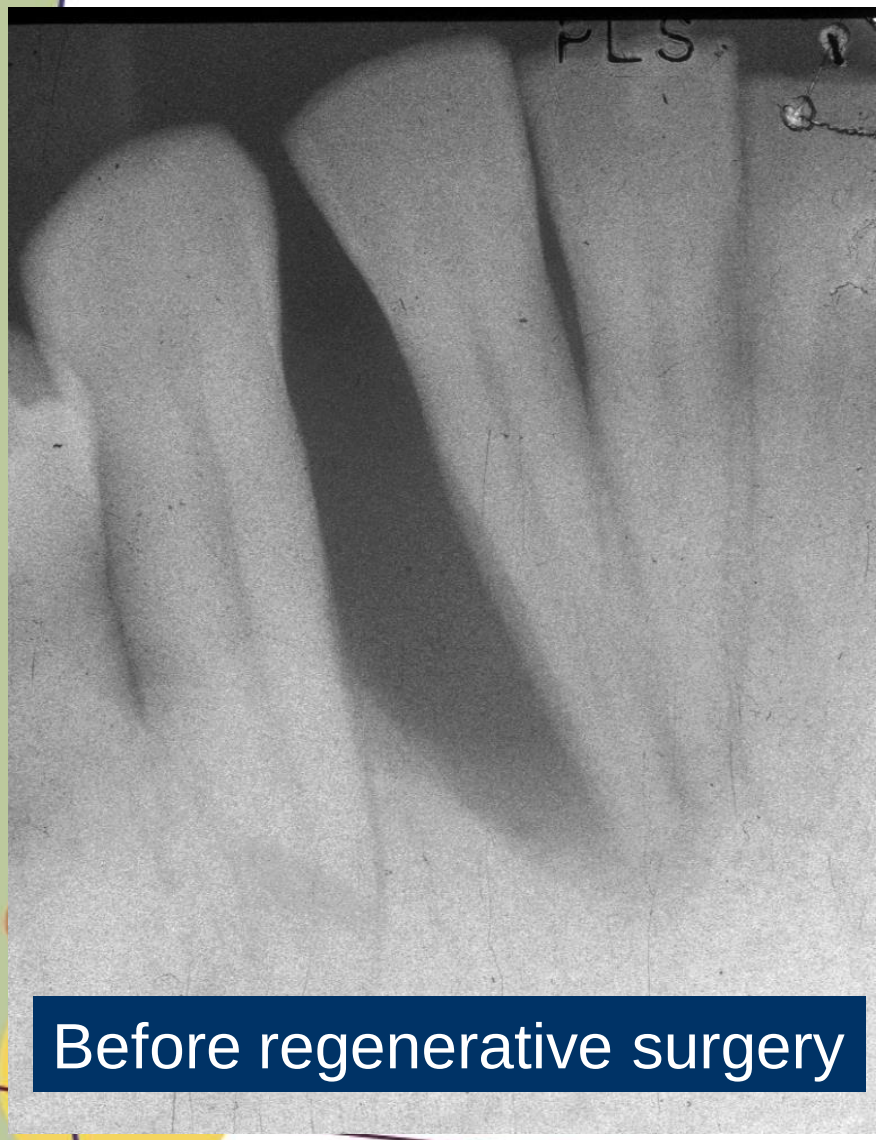
10 months following surgery









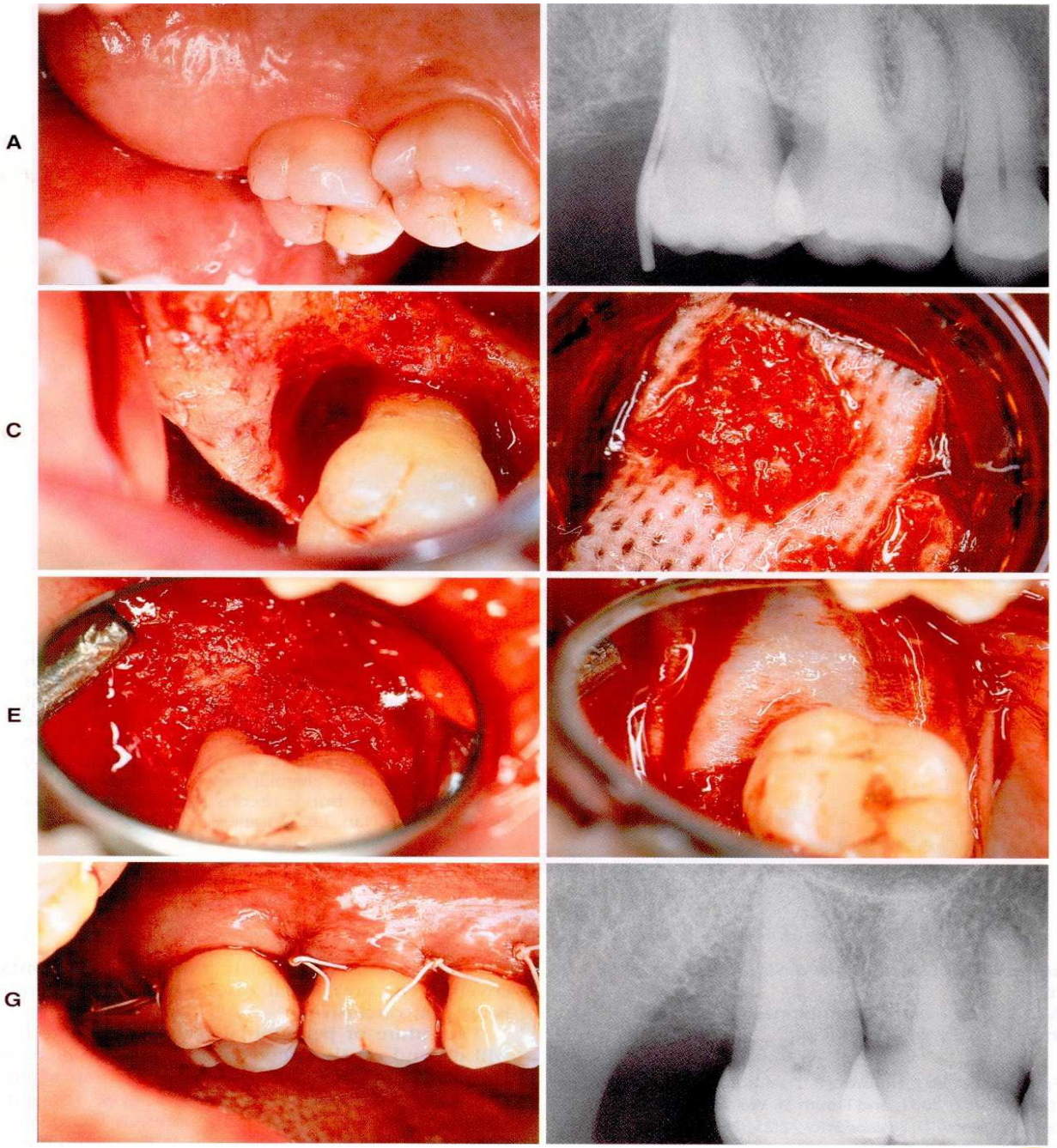


Before regenerative surgery

2mths after flap + Perioglas

Before regenerative surgery

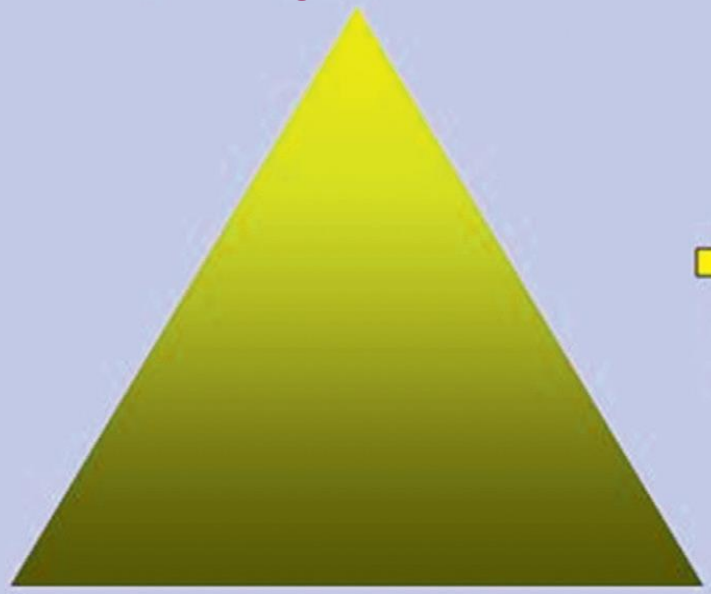
7mths after flap + Perioglas



Biochemical approaches to periodontal regeneration (Tissue Engineering with Biologic Mediators)

- Using tissue engineering, the wound healing process is manipulated so that tissue regeneration occurs.
- This manipulation usually involves one or more of the three key elements: the signaling molecules, scaffold or supporting matrices, and cells

Tissue Engineering Concept



Early clinical examples involving tissue engineering principles include the use of bone allografts and autologous platelet-rich plasma (PRP).

With the development of recombinant growth factors and morphogens, and the use of synthetic scaffolds, the level of success has improved.

Growth factors include:

- platelet-derived growth factor(PDGF)
- insulin-like growth factor (IGF)
- basic fibroblast growth factor (bFGF)
- bone morphogenetic protein (BMP)
- transforming growth factor (TGF)

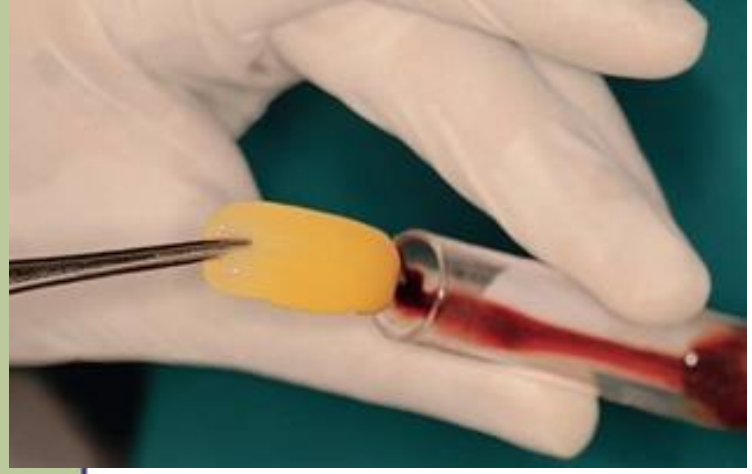
Growth factors in periodontal regeneration

- Group of naturally occurring proteins with varying potent local properties.
- Key regulators of migration, attachment and proliferation of nearly all cell types.
- Growth factors are primarily secreted by macrophages, endothelial cells, fibroblasts, and platelets
- They are used to stimulate periodontal wound healing (promoting migration and proliferation of fibroblasts for periodontal ligament formation) or to promote the differentiation of cells to become osteoblasts, thereby favoring bone formation.

Platelet-derived growth factor (PDGF)

- Important role in wound healing.
- The most recent biologic modifier is platelet derived growth factor (PDGF).
- This material is derived from the patient's own platelet rich plasma. 150ml of whole blood is drawn into a citrated container. The platelet-rich plasma is separated using a platelet separator, like a centrifuge at the chair side, and it is added to autogenous or allogenic bovine bone.
- After placement of the graft material-enriched PDGF, a coat of platelet rich plasma (PRP) is placed over the graft area and the flaps closed.

- Latest generation of platelet concentrates is Platelet rich fibrin.(PRF) It contains fibrin matrix, platelets ,leucocytes, growth factors and stem cells. It encourages soft tissue healing and regeneration.
- Patients blood sample is taken without anticoagulant in a 10 ml tube, centrifuged at 3000 rpm for 10 min.Fibrin cloth is formed in the middle of the tube.



Biochemical approaches to periodontal regeneration (Tissue Engineering with Biologic Mediators)

Root surface biomodification:

- Changes in the tooth surface wall of periodontal pockets (accumulation of bacteria and their products, disintegration of cementum and dentin) interfere with new attachment.
- Although these obstacles to new attachment can be eliminated by thorough root planing, the root surface of the pocket can be treated to improve its chances of accepting the new attachment of gingival tissues.
- Several substances have been proposed for this purpose, including citric acid, fibronectin, and tetracycline.

Biochemical approaches to periodontal regeneration

Citric acid (pH 1)

- Removes/neutralises endotoxin
- Demineralises root surface
- Encourages collagen interdigitation

Tetracycline

- Antibacterial
- Removes smear layer
- Enhances fibroblast binding to root
- Inhibits collagenase

Biochemical approaches to periodontal regeneration

- **Fibronectin**
- Adhesive glycoprotein
- Enhanced fibroblast attachment and proliferation
- **Laminin**
- Epithelial cell attachment protein(found in basement membranes)

  selective attachment and proliferation and differentiation of different cell populations

- **Future periodontal therapy** will include:
- root surface demineralisation to expose the collagenous tooth matrix
- topical application of fibronectin to enhance cell attachment
- application of a combination of polypeptide growth factors in a slow-release biodegradable device to promote the migration, proliferation and maturation of specific progenitor cell populations capable of regenerating the periodontium

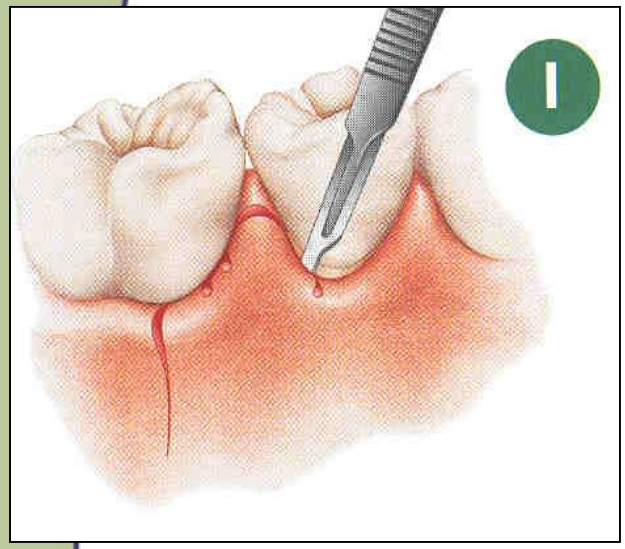
- clinically applicable with two commercially available tissue engineering systems for periodontal regeneration which involve the use of enamel matrix derivative (EMD) and platelet-derived growth factor-BB (PDGFBB)- beta-tricalcium phosphate (β-TCP).
- The ability of BMP type I collagen sponge to enhance periodontal regeneration has been studied with mixed results

Emdogain
enamel matrix proteins

- Emdogain® complex of enamel matrix proteins
- mediates the formation of acellular cementum on the root of the developing tooth
- provides a foundation for all of the necessary tissues associated with a true functional periodontal attachment
- Amelogenin in Emdogain® may be the stimulus that prompts stem cells in the periodontal ligament to divide and differentiate, and produce the additional proteins required for periodontal regeneration.

derived from developing pigs' teeth

- Emdogain® is applied in a gel form directly onto the debrided tooth-root surface during periodontal flap surgery,
- 24% ethylenediaminetetraacetic acid for 15 seconds(EDTA). This removes the smear layer and facilitates adherence of the Emdogain.
- Emdogain® is naturally absorbed by the body, leaving only a residue of enamel matrix proteins on the root surface. This surface layer encourages the migration of cementum-forming cells from the surrounding tissues. Following cementum formation, the periodontal ligament is established and ultimately alveolar bone is formed.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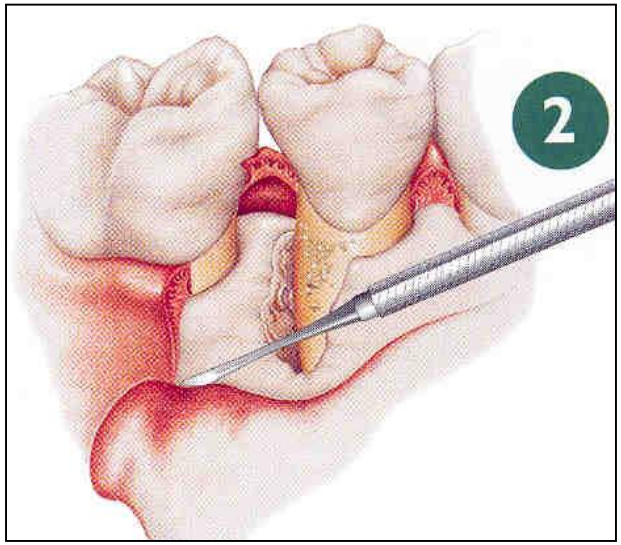
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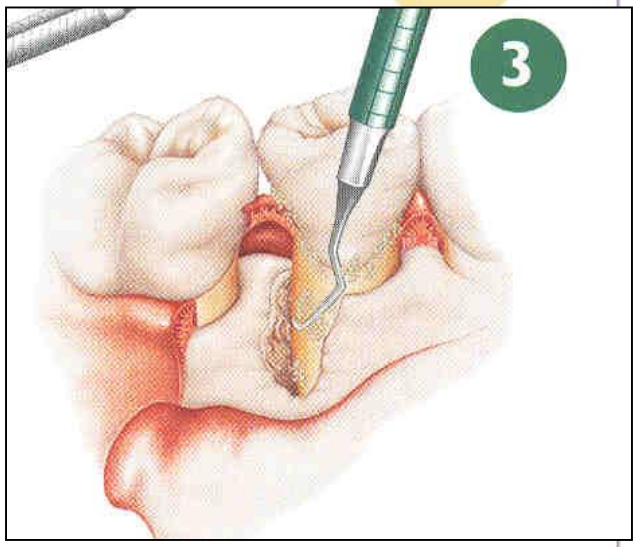
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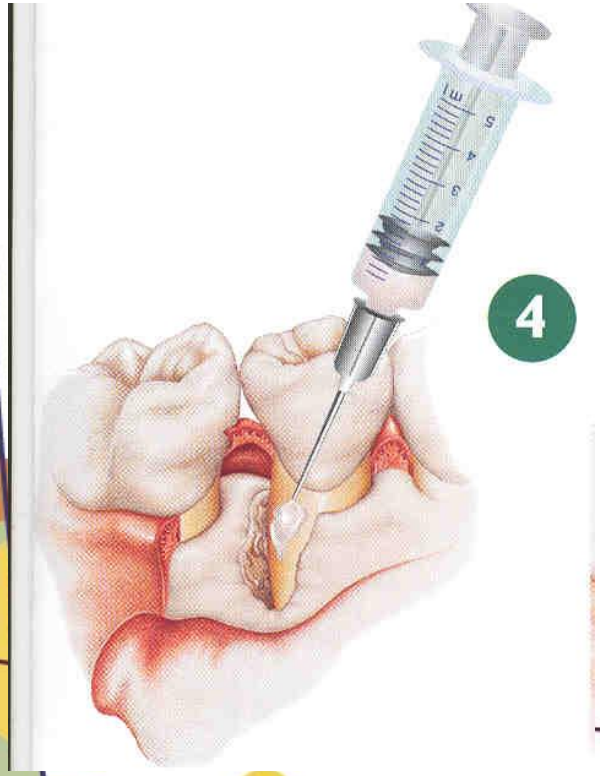
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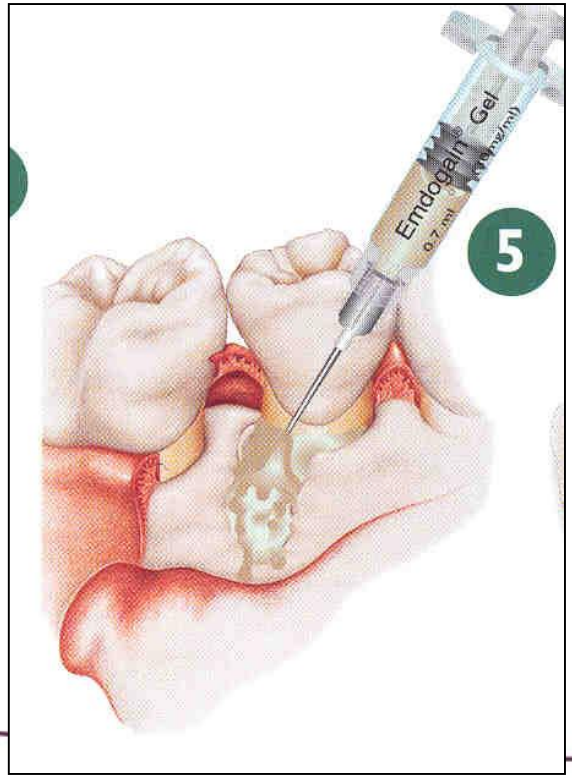
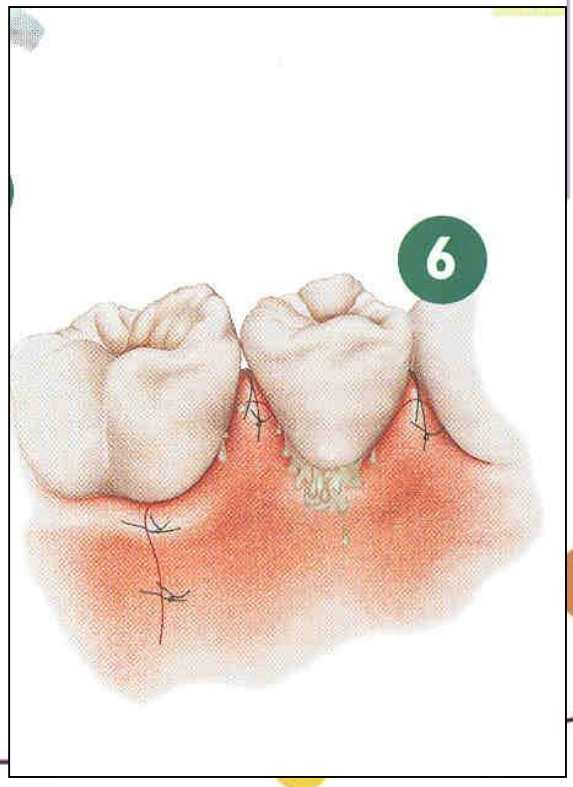

Emdogain® Gel
5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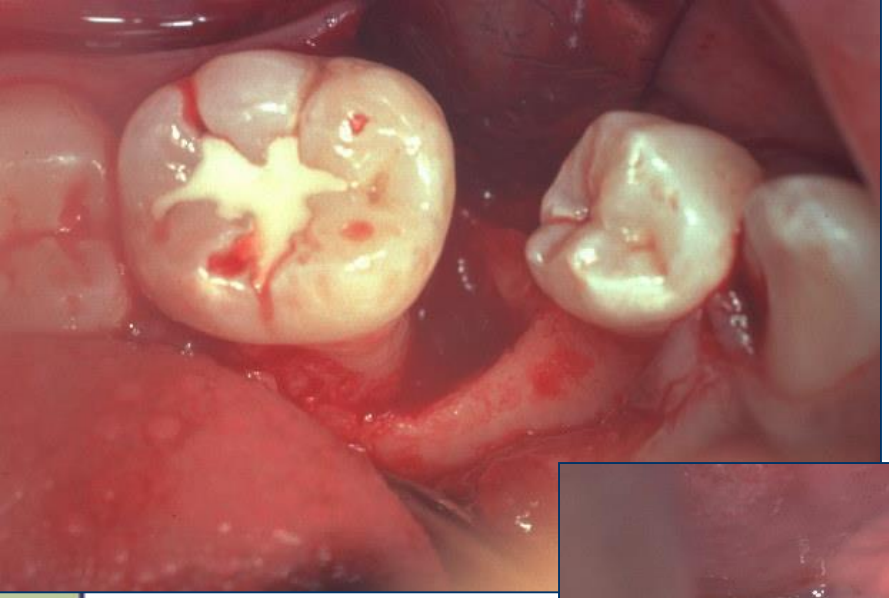
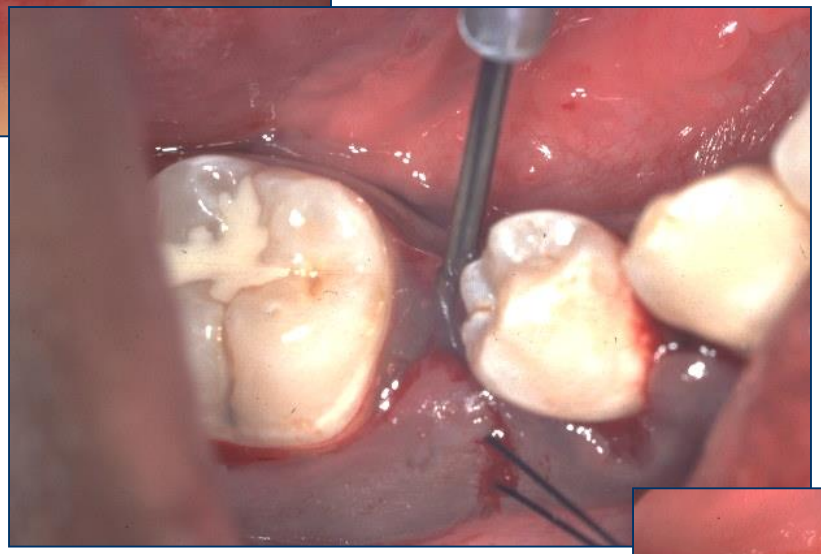
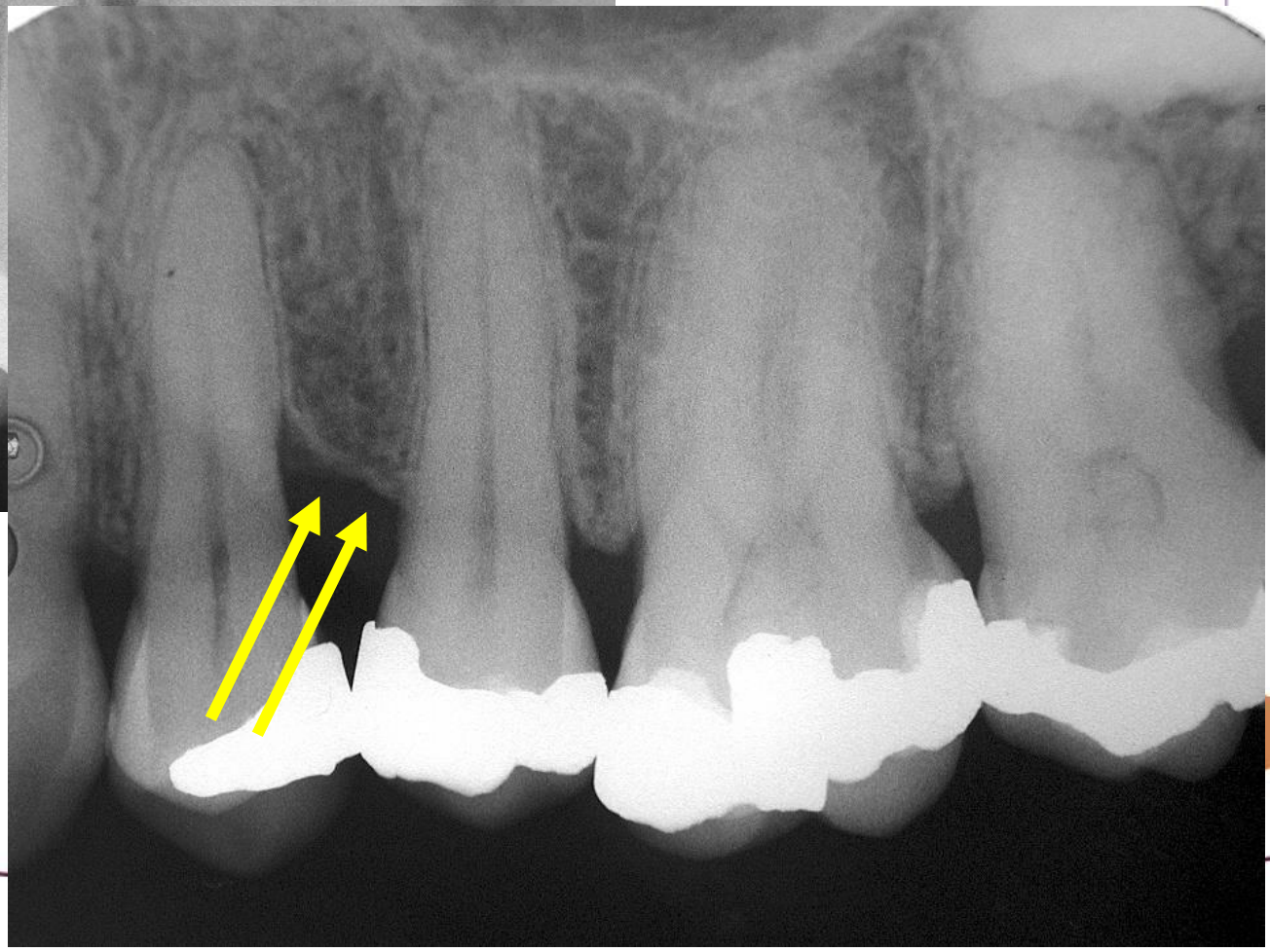




3 months after emdogain



12 months after emdogain

Ref: Carranza’s Clinical Periodontology, Chapter 67:Reconstructive Periodontal Surgery