Development of GBR

IMPLANTOLOGY YEAR COURSE
Module 3

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Aims & Objectives

- What is is GBR?
- How does it work?
- Does it work?

What is GBR?

What is GBR?

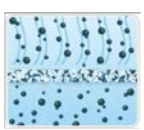
GBR:

Guided Bone Regeneration

What is GBR?

Guided Tissue Regeneration:

GTR developed by Nyman *et al* in early 1980s for periodontal regeneration using Millipore filters



What is GBR?

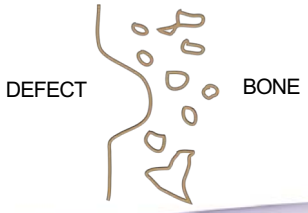
Guided Tissue Regeneration:

Millipore filters (cellulose esters) replaced by expanded polytetrafluoroethylene (ePTFE) membranes in mid-late 1980s.

What is GBR?

Application of a physical barrier:

Allows proliferation of angiogenic and osteogenic cells from bone without interference from fibroblasts



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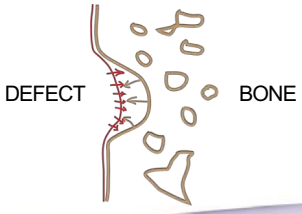


What is GBR?

Fibroblasts:

Fast & aggressive

What is GBR?

Bone cells:

Slow moving, gentile

What is GBR?

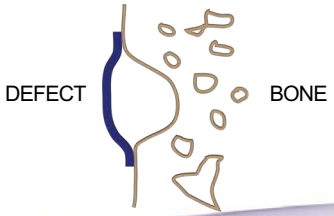
.V.

What is GBR?

What is GBR?

Application of a physical barrier:

Allows proliferation of angiogenic and osteogenic cells from bone without interference from fibroblasts



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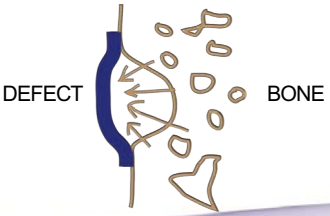
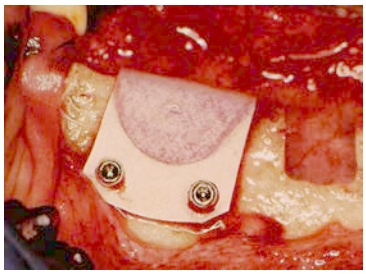


What is GBR?

Foxhound study :

Schenk et al (1994)



Schenk RK, Buser D, Hardwick R, Dahlin C. Healing patterns of bone regeneration in membrane-protected defects: A histologic and histomorphometric study in the mandible of dogs. Int J Oral Maxillofac Implants 1994;9:13-30.

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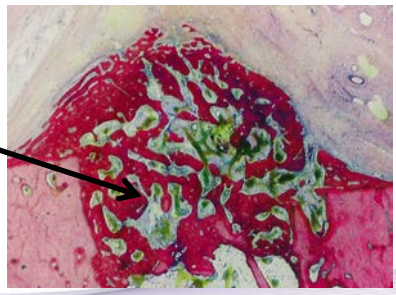

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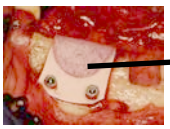

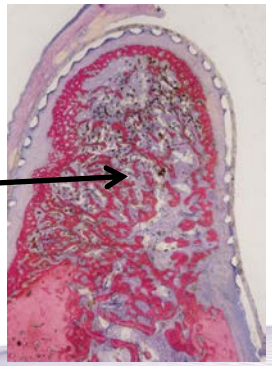

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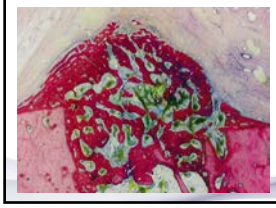

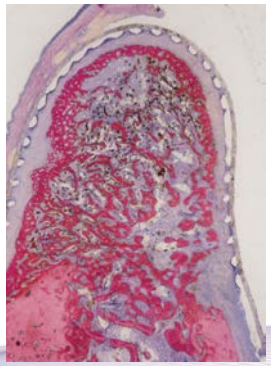

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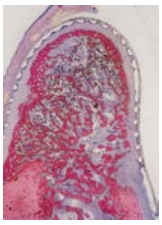
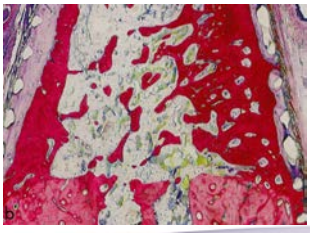
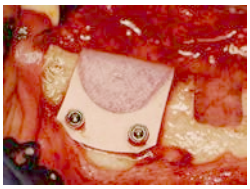




Development of 'fillers'?

Problems with membrane GBR clinically:

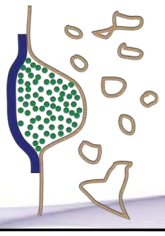
- Membrane collapse
- Formation of a 'periosteum-like' soft tissue under the membrane



Development of 'fillers'

Solution - fillers (autografts/allografts):

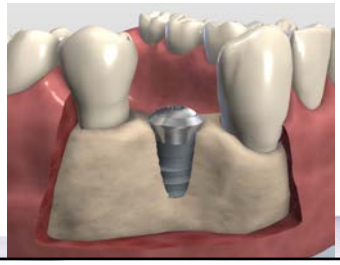
- Supports the membrane
- Stopped 'periosteum-like' tissue formation under membrane



Indications

Coronal dehiscences:

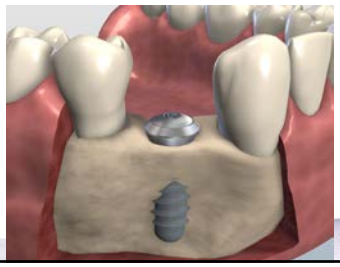
- The more walls, the better the success rate



Indications

Apical dehiscences:

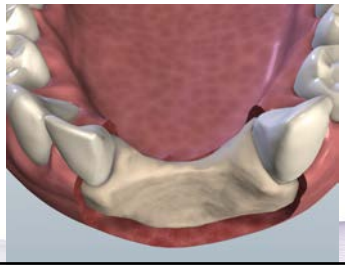
- The more walls, the better the success rate



Indications

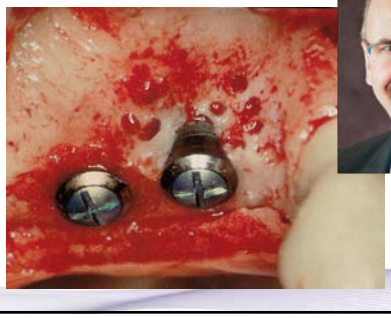
Narrow ridges:

- May respond better to block onlay grafts



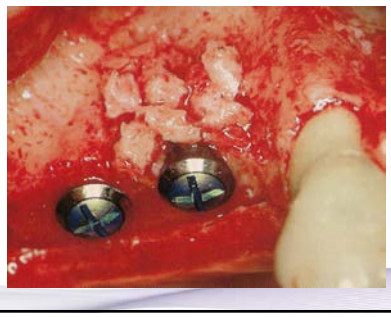
Early clinical cases – Professor Buser

UR4/5 implants with bone dehiscence:



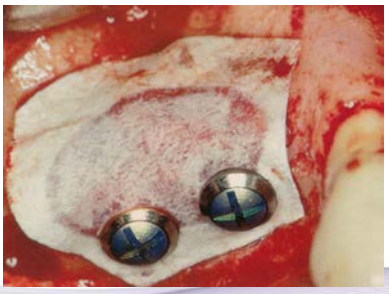
Clinical case example

Application of locally harvested bone chips:



Clinical case example

ePTFE membrane placed:

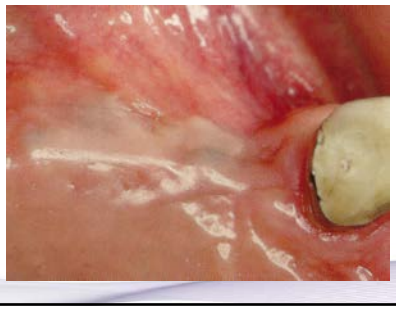


Clinical case example

Periosteum incised & wound closed:

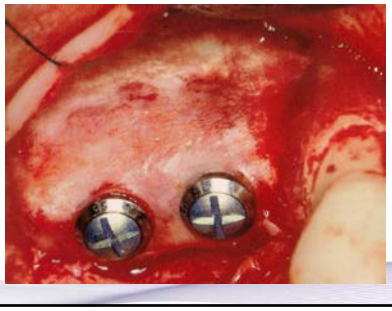
Clinical case example

4 months post-op:



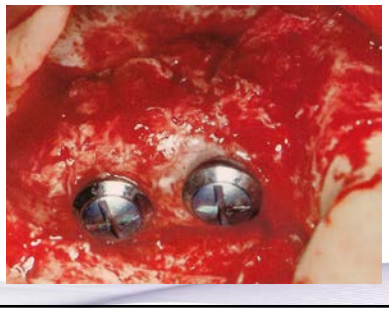
Clinical case example

4 months post-op - surgery to remove membrane:



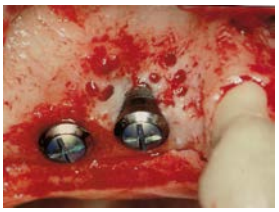
Clinical case example

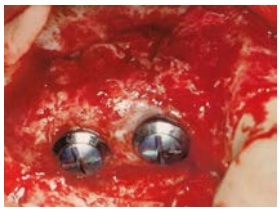
4 months post-op - underneath membrane:



Clinical case example

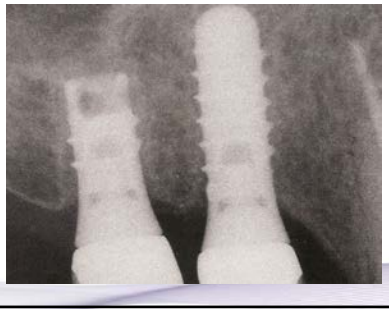
4 months post-op - underneath membrane:





Clinical case example

15 years post-op PA:



Membranes & fillers

Problems with membrane & filler clinically:

- Significant rate of membrane exposures from soft tissue dehiscences
- ....often leading to infections
- Hydrophobic ePTFE membranes difficult to handle, needed tacking
- Need for 2nd surgery to remove membrane

Membranes

Non resorbable

Resorbable

Membranes

Requirements:

- Occlude cells
- Biocompatable
- Good handling properties
- Low complication rate
- Tissue integration

Membranes - cell occlusion

Cell occlusion:

Exclude connective tissue cell invasion but still allow nutrient transfer.

Studies have shown that macroporous membranes have lower complication rate than totally occlusive barrier membranes

Membranes - biocompatability

In general:

Inert materials less of an issue than degradable materials

Membranes - biocompatability

Degradable materials:

The material, the intermediate breakdown products and the final breakdown products all need to be taken into account

Membranes - tissue integration

Tissue integration:

Non-porous, non textured materials result in fibrous tissue capsulation - no tissue attachment

Materials which integrate with tissues allow the tissues to improve mechanical stability of membrane

Non-resorbable membranes

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Non-resorbable membranes ePTFA

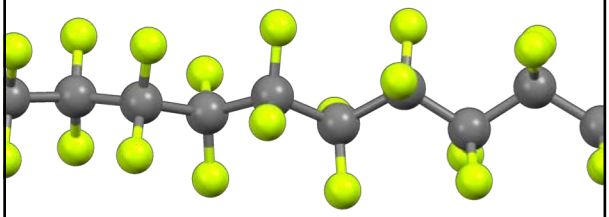
PTFE - polytetrafluoroethene (Teflon)

PTFE (Teflon) – Roy Plunckett 1938

1938 – working on refrigeration gases (CFCs)

PTFE (Teflon) – Roy Plunckett 1938

1938 – working on refrigeration gases (tetraflouroethylene)



PTFE (Teflon) – Roy Plunckett 1938

1938 – working for DuPont

PTFE (Teflon) – Manhattan Project

PTFE (Teflon) – Fishing Tackle

Non-resorbable membranes ePTFA

Tefal

- Extremely strong bonds C-F
- No known enzyme can cleave C-F bond
- Allows material to be biologically inert

Non-resorbable membranes ePTFA

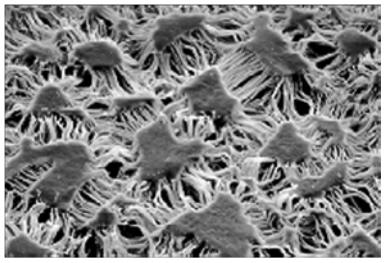
ePTFE - *expanded* polytetrafluoroethylene

- William Gore - chemist
- Until 1957 worked for DuPont!
- Started a company in his basement in 1958, making PTFE insulated computer cabling.

Non-resorbable membranes - ePTFA

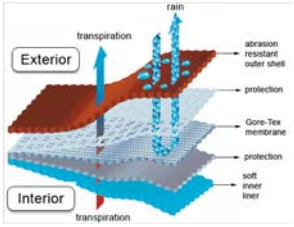
I decided to give one of these rods a huge stretch, fast, a jerk... and it stretched 1000%

Non-resorbable membranes - ePTFA



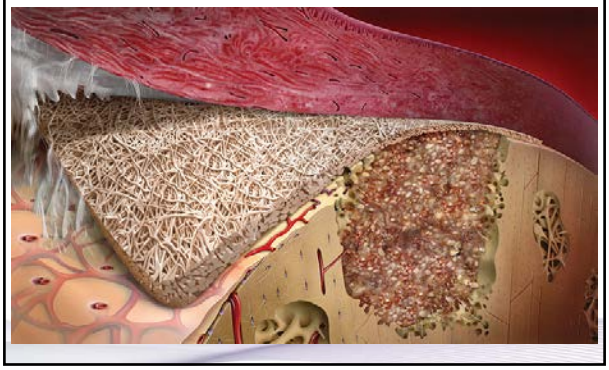
Non-resorbable membranes ePTFA

ePTFE - *expanded* polytetrafluoroethylene (Gore-Tex)



Allows passage of gases & vapour but not liquids

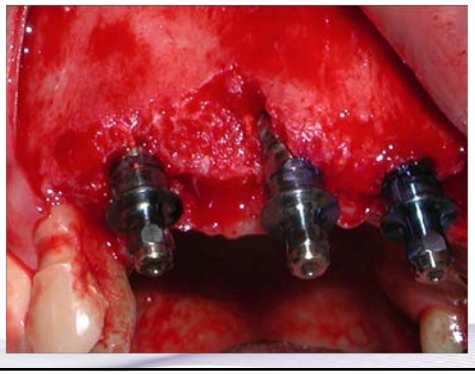
Non-resorbable membranes ePTFA (GoreTex)



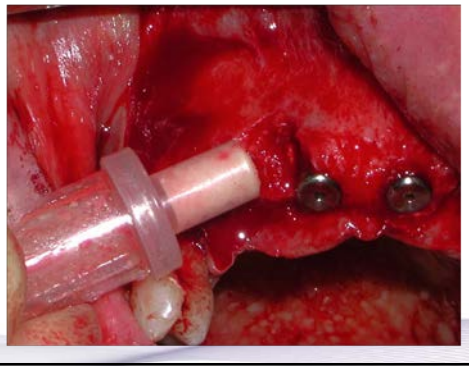
Non-resorbable membranes ePTFA (Gore)

- Used in perio & oral surgery 1980s - early 1990s
- Wound dehiscences common
- Infections common
- Hydrophobic - difficult to handle
- Needed pins & tacks
- No tissue integration
- Second surgery to remove

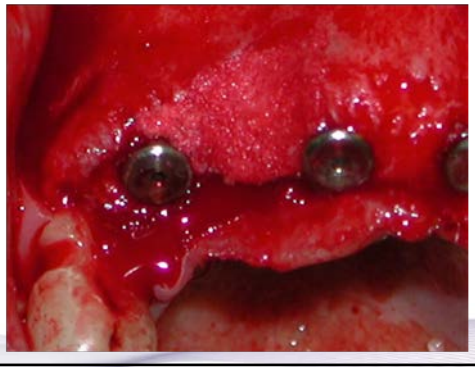
Non-resorbable membranes ePTFA (Gore)



Non-resorbable membranes ePTFA (Gore)



Non-resorbable membranes ePTFA (Gore)



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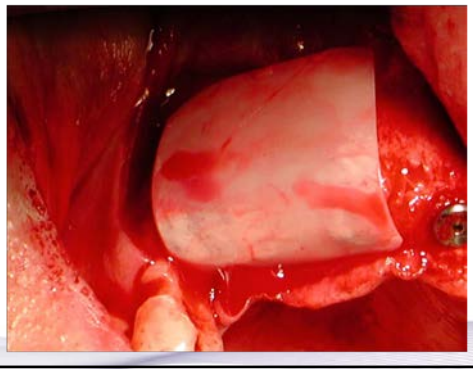

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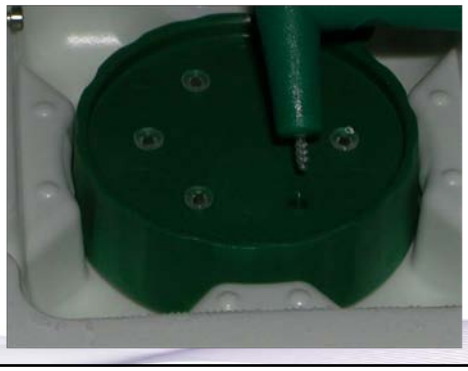

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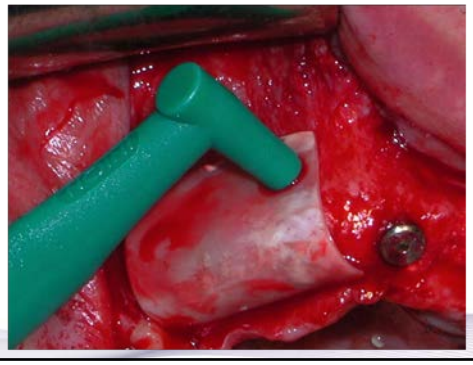

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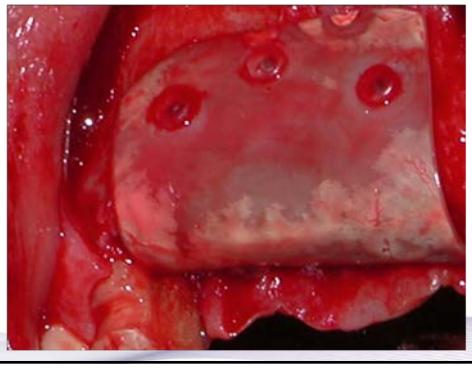


Membranes & fillers

Therefore needed was:

- Hydrophillic membranes
- Bioresorbable membranes

Bioresorbable membranes

Two main types developed:

- Polymers (i.e. polylactic acid/polyglycolic acid)
- Collagen membranes

Resorbable membranes

Resorbable membranes

Synthetic

+

Organic

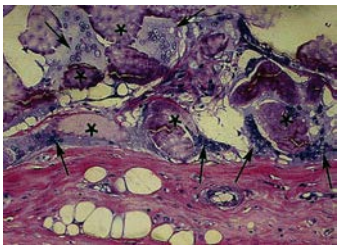
Resorbable membranes - synthetic

Polymers - PGA (polyglycolides)/PLA (polyactides)

- Synthetic - unlimited availability
- Fully degrade (Krebs cycle) to water & CO2
- Associated with foreign body reactions
- Associated with inflammatory respones

Resorbable membranes - synthetic

Polymers - PGA (polyglycolides)/PLA (polyactides)



Large multinucleated giant cells (arrowed)

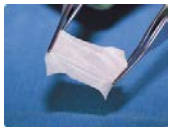
Resorbable membranes - organic

Collagen - non cross linked/cross linked

- Type I or Type I & III
- Porcine dermis, equine, bovine dermis/tendon
- Bioresorbable
- Haemostatic
- Hydrophilic - handling properties
- Enzymic degradation by macrophages/PML

Resorbable membranes - organic

Collagen - Geistlich Bio-Gide



Resorbable membranes - organic

Collagen - Creos

Resorbable membranes - organic

Collagen

- Complete degradation 6 - 16 weeks
- Good nutrient permeability
- Low incidence of dehiscences/infections
- Resorbs quickly if exposed (soft tissues heal fast)
- Bilayer design

Resorbable membranes - organic

Collagen - double layer technique

For increased support in larger defects

Resorbable membranes - organic

Collagen - can be secured with resorbable tacks

For increased support in larger defects

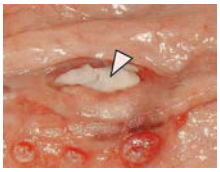
Resorbable membranes - organic

Collagen - cross-linked

- Prolongs barrier function times (>12 weeks)
- Prolongs degradation
- Decreases nutrient permeability
- Increased incidence soft tissue dehiscences
- Associated with infections and severe inflammatory responses

Resorbable membranes - organic

Collagen - cross-linked showing dehiscence (canine)



- Resists bacterial enzymtic degradation
- Becomes infilltrated with bacteria and colonised

Conclusion – collagen membranes

Advised collagen membranes:

- Non cross-linked collagen material of choice
- Good handling characteristics
- Hydrophilic
- Stick to bone well (often no need to tack)
- Low risk of post operative complications
- Eliminates need for second surgery
- Can use double layer technique

New Developments

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Resorbable membranes - organic

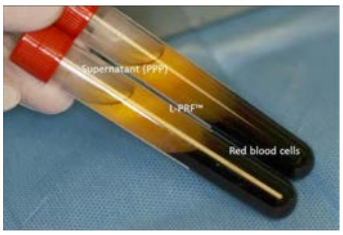
PRF - Platelet Rich Fibrin

Resorbable membranes - organic

PRF - Platelet Rich Fibrin

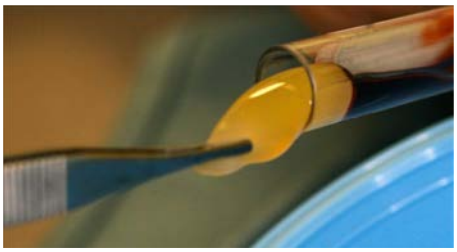
Resorbable membranes - organic

PRF - Platelet Rich Fibrin



Resorbable membranes - organic

PRF - Platelet Rich Fibrin



Resorbable membranes - organic

PRF - Platelet Rich Fibrin

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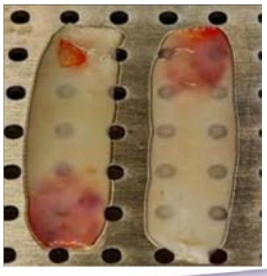
Resorbable membranes - organic

PRF - Platelet Rich Fibrin



PRF - Platelet Rich Fibrin

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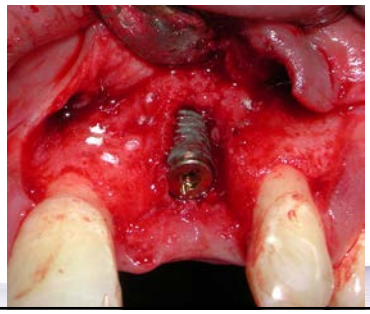
THE END

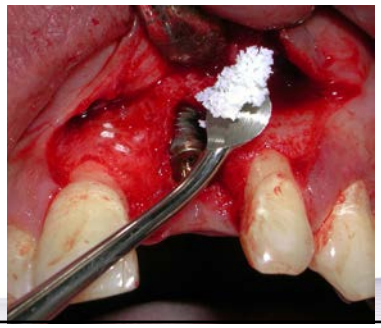
Clinical case example

Dehiscence:



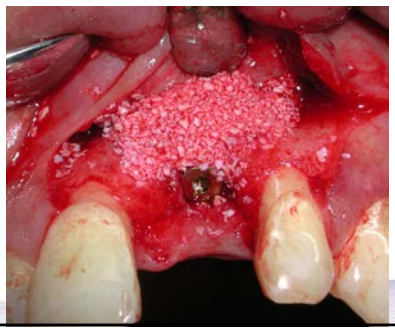
Clinical case example

Particulate graft:



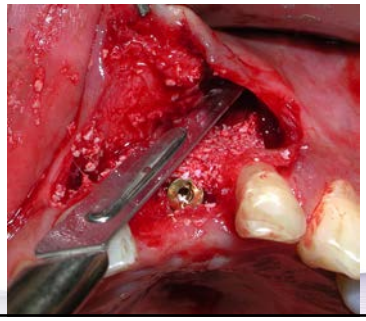
Clinical case example

Packing of material:



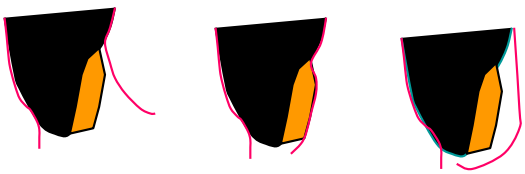
Clinical case example

Releasing periosteum:



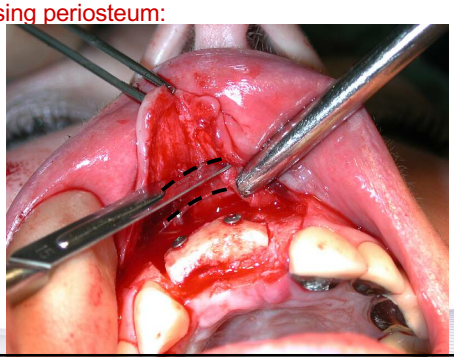
Clinical case example

Releasing periosteum:



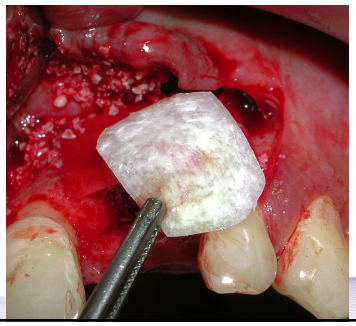
Clinical case example

Releasing periosteum:



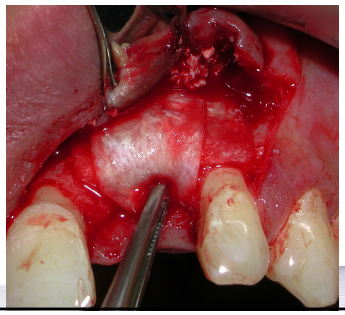
Clinical case example

Barrier membrane placement (collagen):



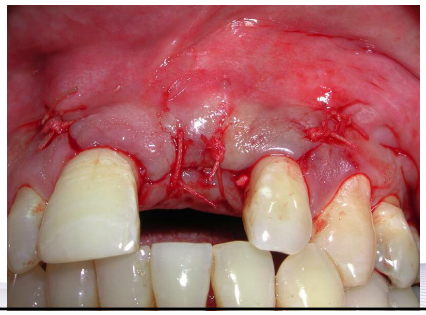
Clinical case example

Barrier membrane placement (collagen):



Clinical case example

Wound closure:



THE END