BIOACTIVE MATERIALS

ACTUAL TRENDS IN RESTORATIVE DENTISTRY AND ENDODONTICS

- Minimal intervention

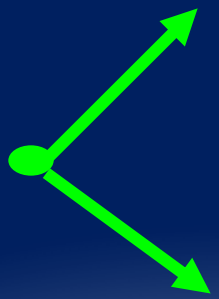
- Improvement of the healing potential of dental pulp and supportive tissues

PRIMUM NON NOCERE !

Minimal intervention

=

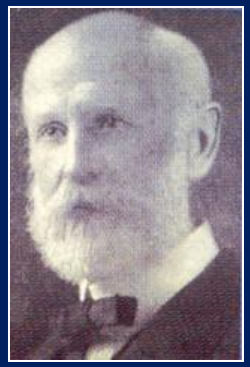
Approach



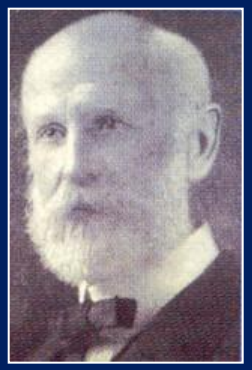
Non invasive

Minimally invasive

EXTENTION FOR PREVENTION !



PREVENTION OF EXTENTION !



„If we recognized real reasons of dental caries we would be able to heal the caries lesion.“

(G.V. Black 1900)

MINIMAL INTERVENTION

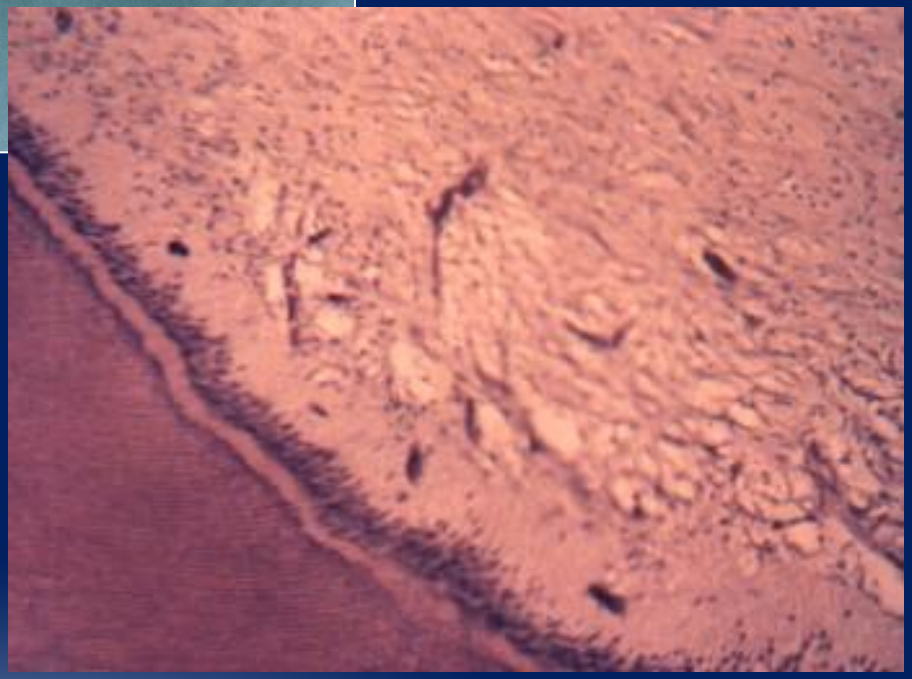
- Etiology and pathogenesis of dental caries
- Study of healing possibilities of dental pulp and periodontal tisues
- Study of mechanical resistance of teeth
- Diagnosis
- Preparation techniques
- Filling materials

Paradigm shift in treatment of dental caries, non carious lesions and endodontics

MINIMAL INTERVENTION

- **Study of healing possibilities of dental pulp and periodontal tisues**

Paradigm shift in treatment of dental caries, non carious lesions and endodontics

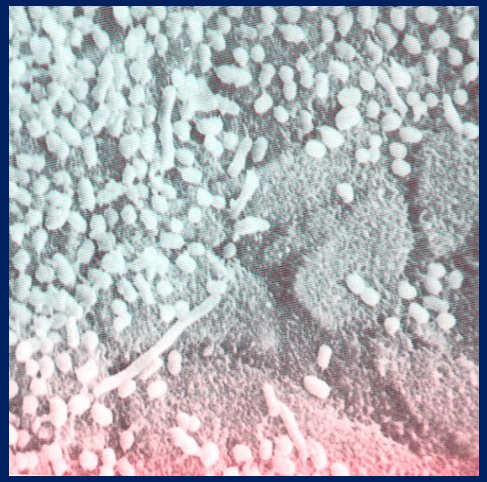


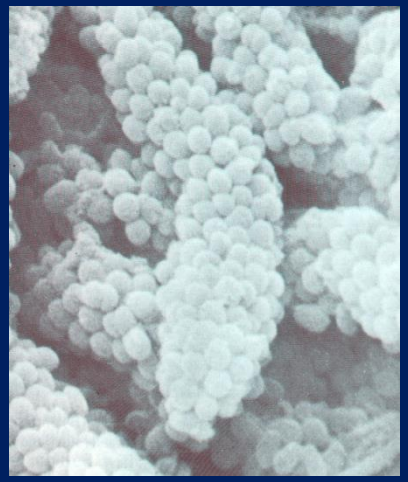
MINIMAL INTERVENTION

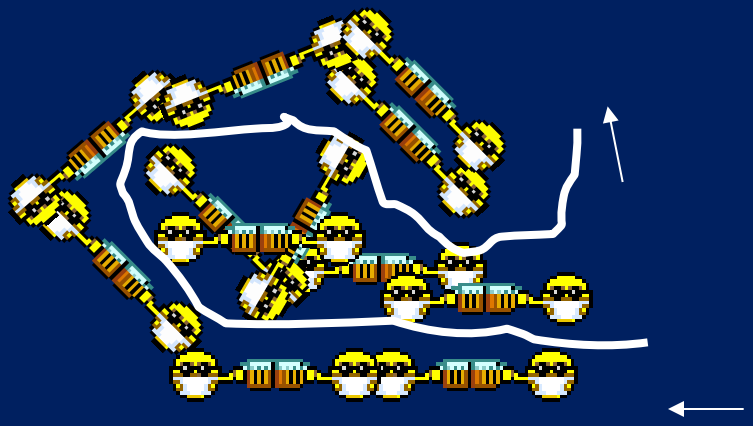
- **Etiology and pathogenesis of dental caries**

Paradigm shift in treatment of dental caries, non carious lesions and endodontics

BIOFILM







Importance of oral hygiene

Decrease of cariogenic potential of dental biofilm

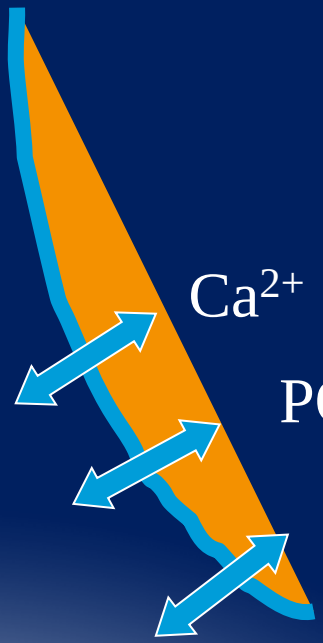
$Ca_{10}(PO_4)_6(OH)_2$

$Ca_{10}(PO4)_6F_2$

Ca^{2+}

PO_4^{3-}

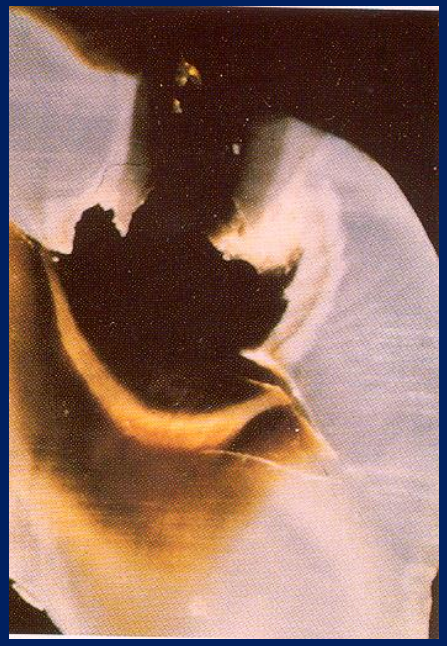
F-

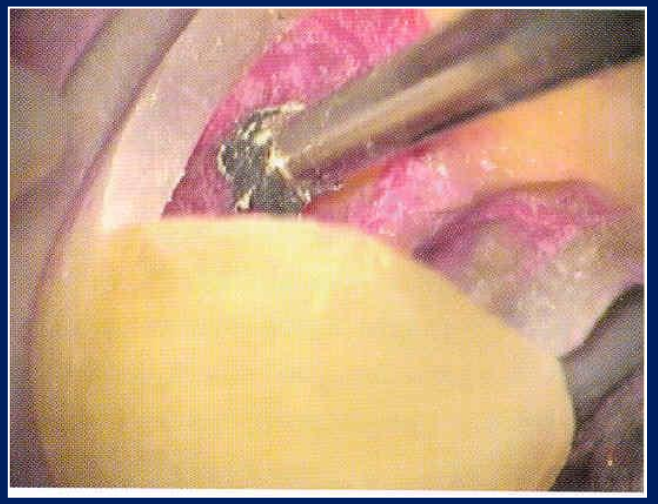


Ca^{2+}

PO_4^{3-}

OH^-





Is there any possibility to remineralize dentin?

How much of carious dentin should be removed?

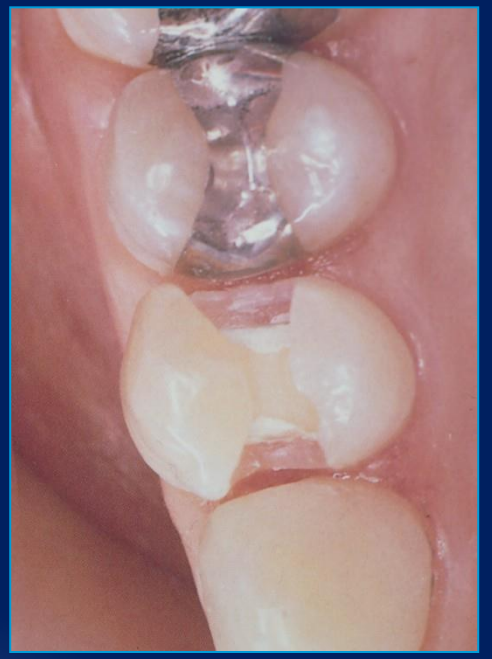
MINIMAL INTERVENTION

- **Study of the mechanical resistance of teeth**

Paradigm shift in treatment of dental caries, non carious lesions and endodontics

REDUCTION OF THE RESISTANCE

MOD - 63%

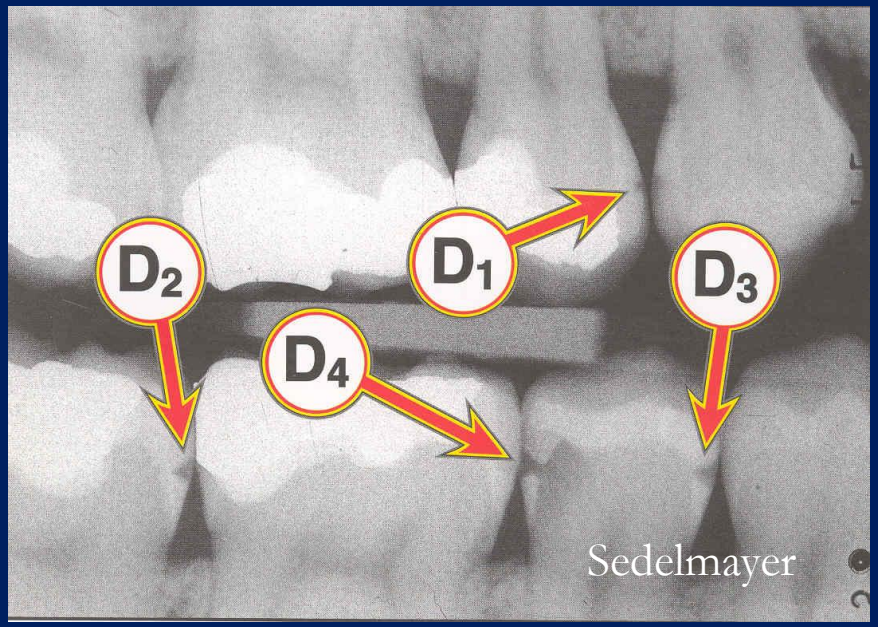


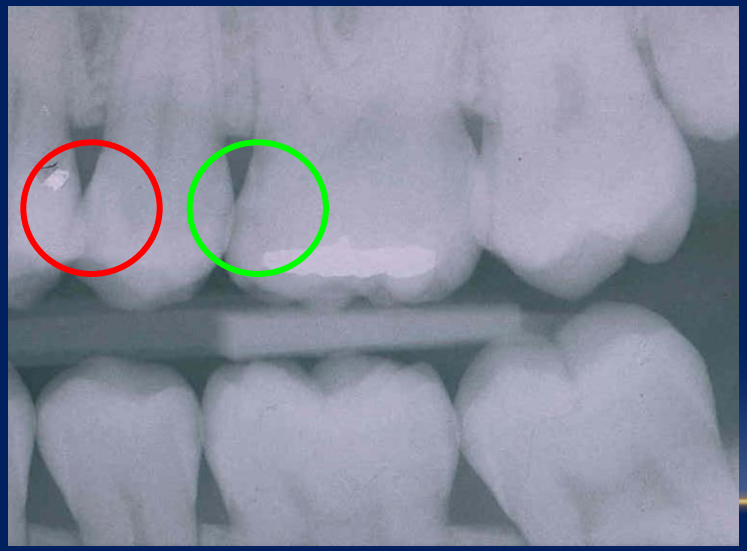
Ferrari M, Scotti R. Fiber posts. Characteristics and clinical applications. Milano: Masson,2002.c

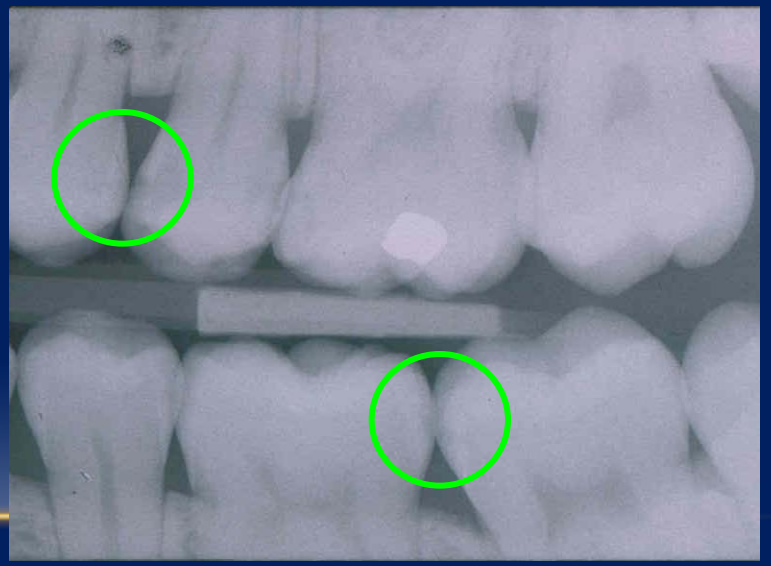
MINIMAL INTERVENTION

- **Diagnosis**

Paradigm shift in treatment of dental caries, non carious lesions and endodontics







RTG vyšetření – Bite Wing

DIAGNOSIS

- **ECM** Electrical Caries Monitor

  (Verdonschot 1992)

- **FOTI** Fibre Optic Trans Illumination

  (Stephen et al. 1987)

- **QLF** Quantitative Light-induced Fluorescence

  (Hail et al. 1987)

- **IRLF** Infra Red Laser Fluorescence

  (Lussi et al. 1999)

Peters MC, Mc Lean ME: Minimally invasive operative care I. Minimal Intervention and Concepts:J Adhes Dent 2001; 3:5 –16.

MINIMAL INTERVENTION

- **Preparation techniques**

Paradigm shift in treatment of dental caries, non carious lesions and endodontics

MINIMAL INTERVENTION

- **Filling materials**

Paradigm shift in treatment of dental caries, non carious lesions and endodontics

IDEAL FILLNIG MATERIAL – DOES IT EXIST?

It should be

easy to handle
multi-purpose material
one increment technique
no shrinkage
tooth colored
biocompatible & bioactive
resistant
tolerant

AMALGAM

- No aesthetic

- No connection to hard dental tissue

- Thermal conductivity

- Big lost of hard dental tissue due to proper preparation

- Toxicological aspects

COMPOSITE

- Aesthetic
- Good connection to enamel and dentin
- No cariostatic potential
- Exacting technology – dry operating field

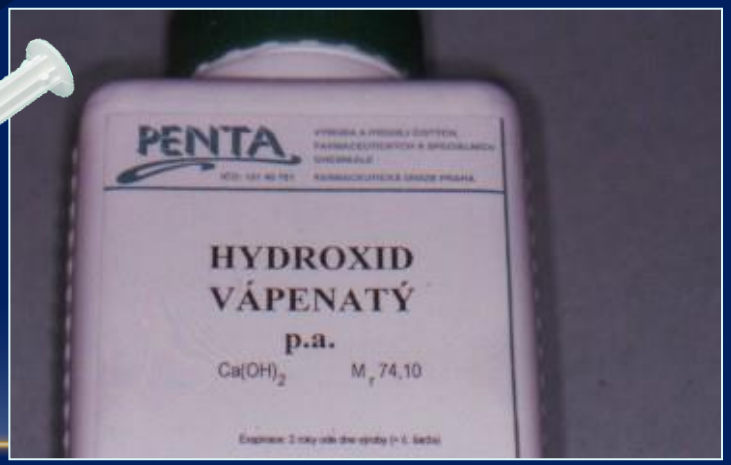
GLASSIONOMERS

- Good connection to hard dental tissues esp. to enamel (chemical binding)
- Favourable thermal expansion
- Cariostatic effect (releasing of fluoride ions), remineralization of dentin (acidoresistant barrier)
- Not strong enough (abrasion), acidic
- Not so aesthetic as composite materials

- None of filling contemporary filling does improve the healing potential of dental pulp and/or solve endodontics problems!

CALCIUM HYDROXIDE

- Pulp capping
- Pulpotomy
- Temporary root canal filling
- Apexification



WE NEED A NEW MATERIAL !!!!

The main criteria:

- Criterion 1: A single material, no prior treatment of the tooth surfaces required, straightforward to use.
-
- Criterion 2: A non-metallic material with aesthetic qualities that patients find acceptable for use in the posterior regions.
-
- Criterion 3: A material which has undisputable biological qualities and is sufficiently long-lasting.

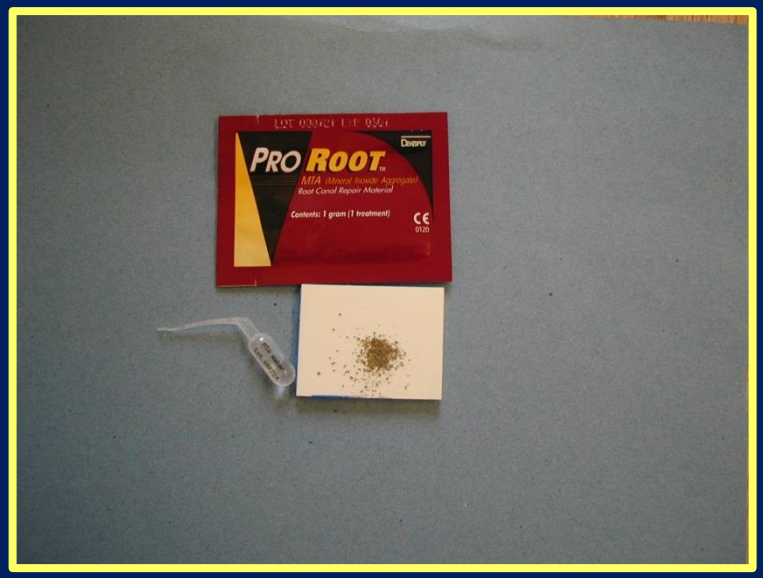
(*Colon, Villat)*

PORTLAND CEMENT - MTA

- Ca_3Si *Calcium trisilicate*
- Ca_2Si *Calcium disilicate*
- Ca_3Al *Calcium aluminate*
- Ca_4AlFe *Calcium aluminoferrite*
- $CaSO_4$ *Calcium sulphate*
- BiO_3 *Bismuth trioxide*

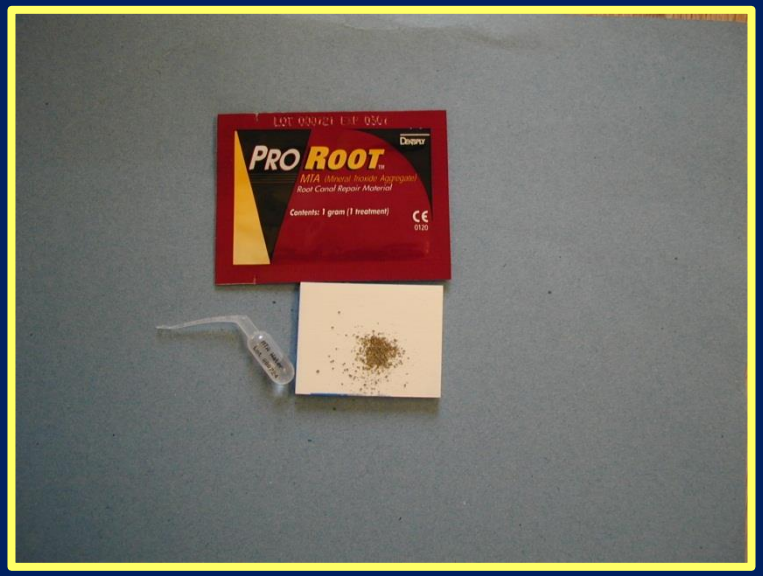
+

Water

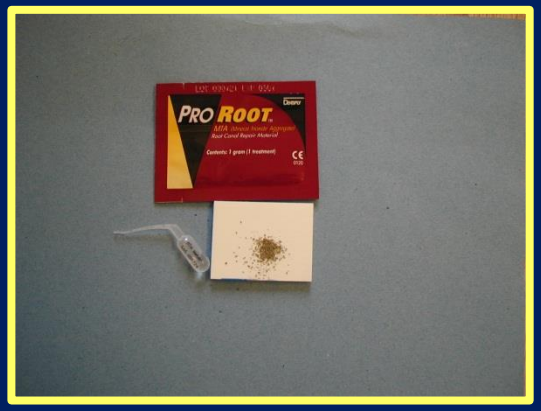


PORTLAND CEMENT - MTA

- ***Pulp capping***
- ***Pulpotomy***
- ***Apexification (no multiple visit)***
- ***Endodontic repair material***
- ***Surgical endodontics***



PORTLAND CEMENT - MTA



Problems

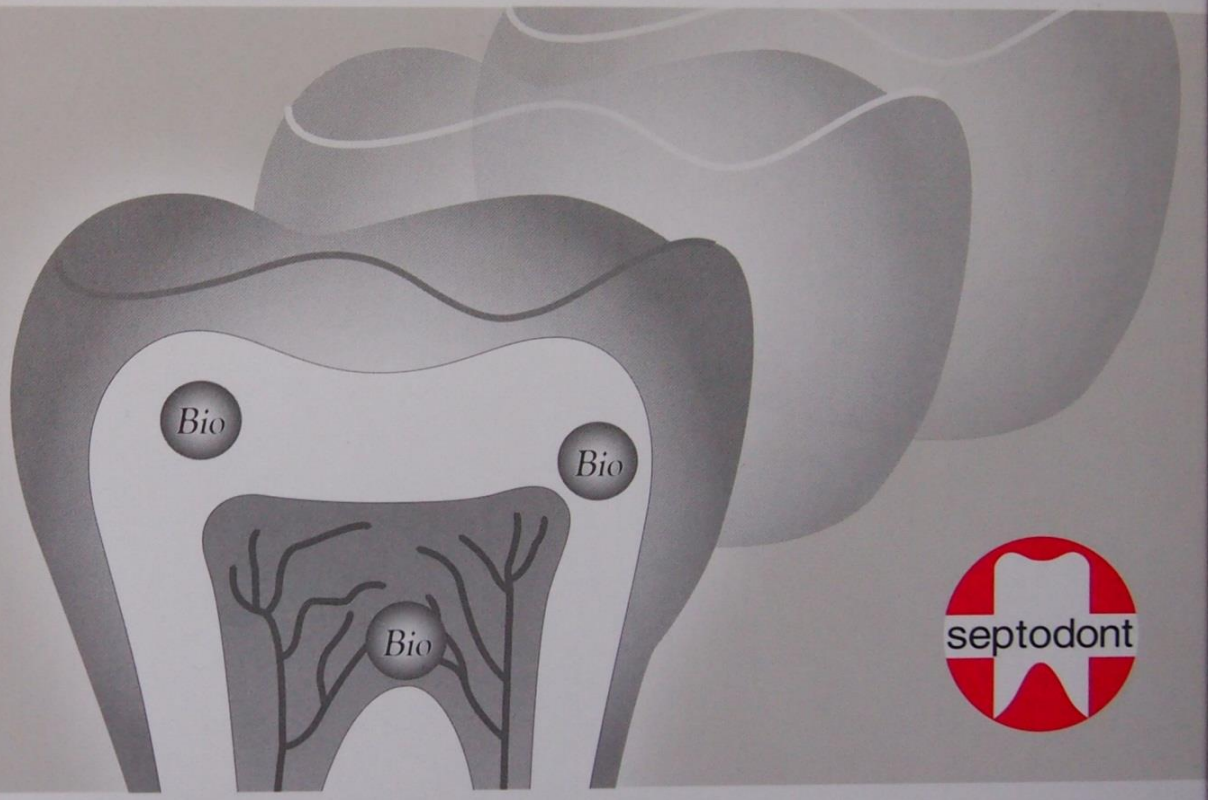
- To obtain sufficient mechanical strength values.
- To accelerate the setting reaction to obtain early strength compatible with its use in clinical practice.
- To improve the conditions for use so that it can be inserted in a cavity and modelled properly.
- To manage the costs so that it can be used routinely.
- The main problem are the aluminate components, which make the product fragile.

ACTIVE BIOSILICATE TECHNOLOGY

Biodentine™

septodont

Substitut dentinaire bioactif
Bioactive dentine substitute



15 x 700 mg 15 x 0.18 mL

SEPTODONT
58, rue du Pont de Créteil
94107 Saint-Maur-des-Fossés Cedex
France
Tel : 33 (0) 1 49 76 70 00

CE 0459

ACTIVE BIOSILICATE TECHNOLOGY ™ SEPTODONT

Active Biosilicate Technology™ is a proprietary technology developed according to state-of-the-art pharmaceutical background applied to the high temperate ceramic mineral chemistry.

BIODENTINE - COMPOSITION

- Powder

Ca_3SiO_5 (tricalcium silicate C3S)	Main core material
Ca_2SiO_5 (dicalcium silicate C2S)	Second core material
$CaCO_3$ (calcium carbonate)	Filler
CaO (calcium oxide)	Filler
Fe_2O_3 (iron dioxide)	Shade
ZrO_2 (zirconium dioxide)	Radiopacifier

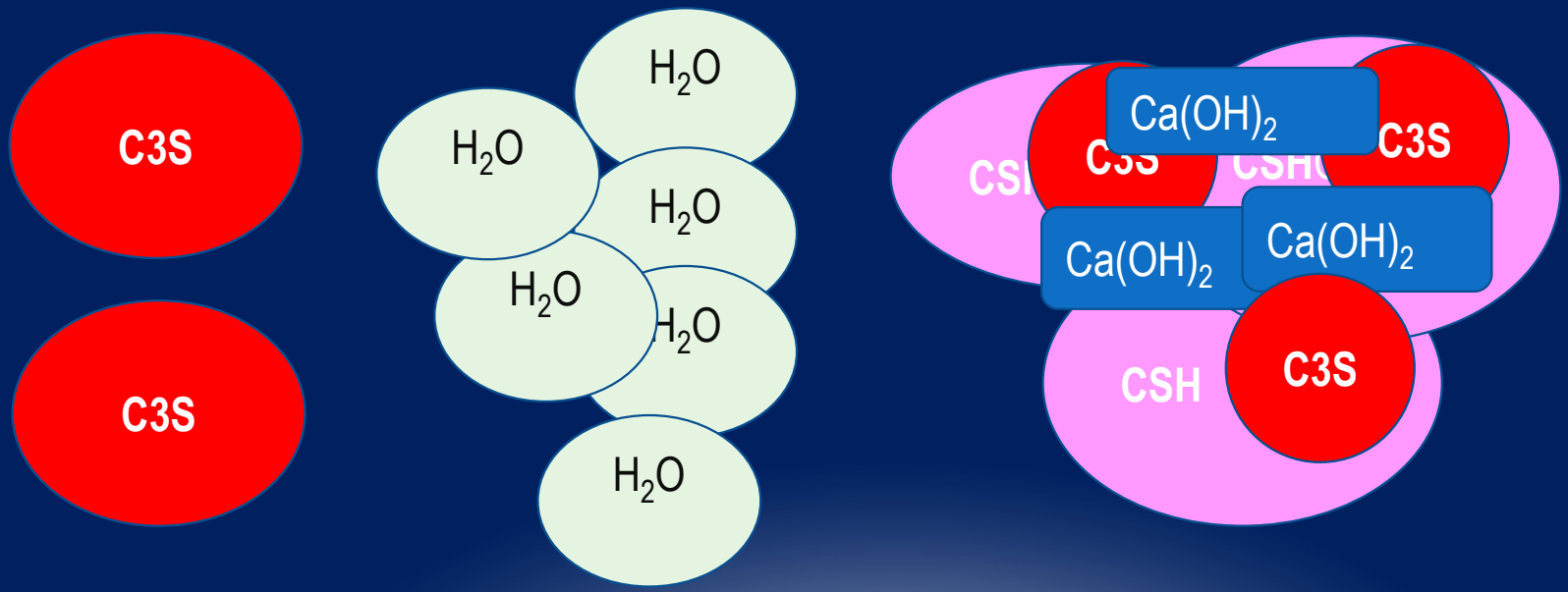
- Liquid

$CaCl_2 . 2 H_2O$	Accelerator
Hydrosoluble polymer	Water reducing agent
Water	

BIODENTINE – SETTING REACTION

- $2(3CaO.SiO_2) + 6H_2O \rightarrow 3CaO.2SiO_2.3H_2O + 3Ca(OH)_2$

C3S **CSH**



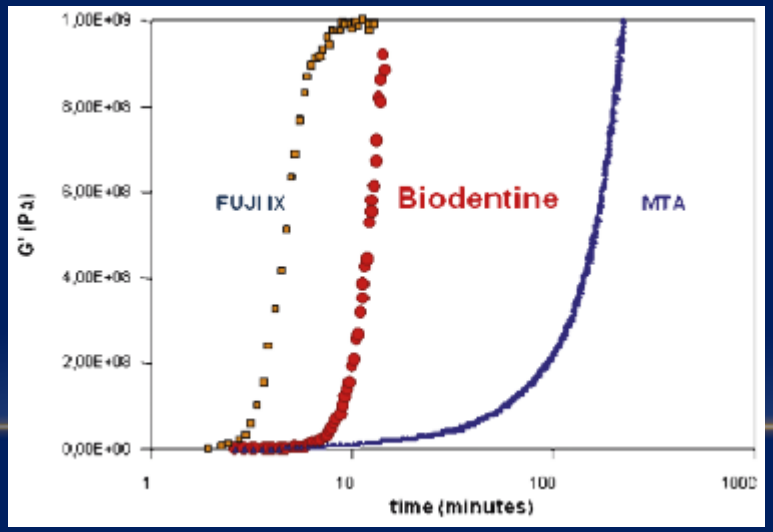


The hardening process results from of the formation of crystals that are deposited in a supersaturated solution.

Setting time: 9 -12 min.

SETTING TIME

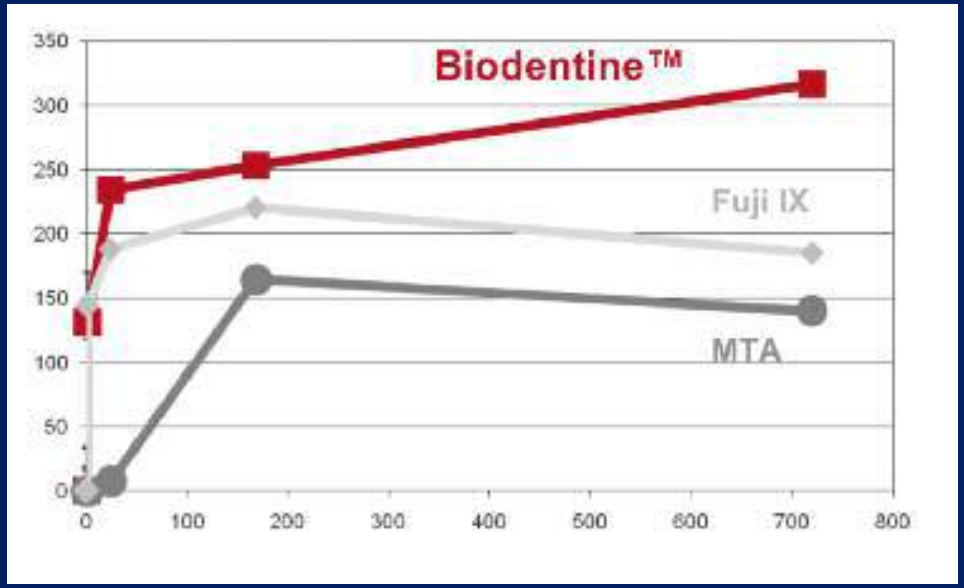
The working time of Biodentine™ is up to 6 minutes with a final set at around 10-12 minutes. The classical glass ionomer sets faster that Biodentine™ in less than 4 minutes. This represents a great improvement compared to the other calcium silicate dental materials (ProRoot® MTA), which set in more than 2 hours.The setting times of Biodentine™ are in the same range as the amalgams



POROSITY

Biodentine™ exhibits lower porosity than ProRoot® MTA. The density and the porosity of Biodentine™ and Fuji IX are equivalent.

COMPRESSIVE STRENGTH



MICRO HARDNESS

The reported micro hardness values for natural dentine are in the range of 60-90 HVN.

(O'Brien 2008). Biodentine™ has surface hardness in the same range as natural dentine.

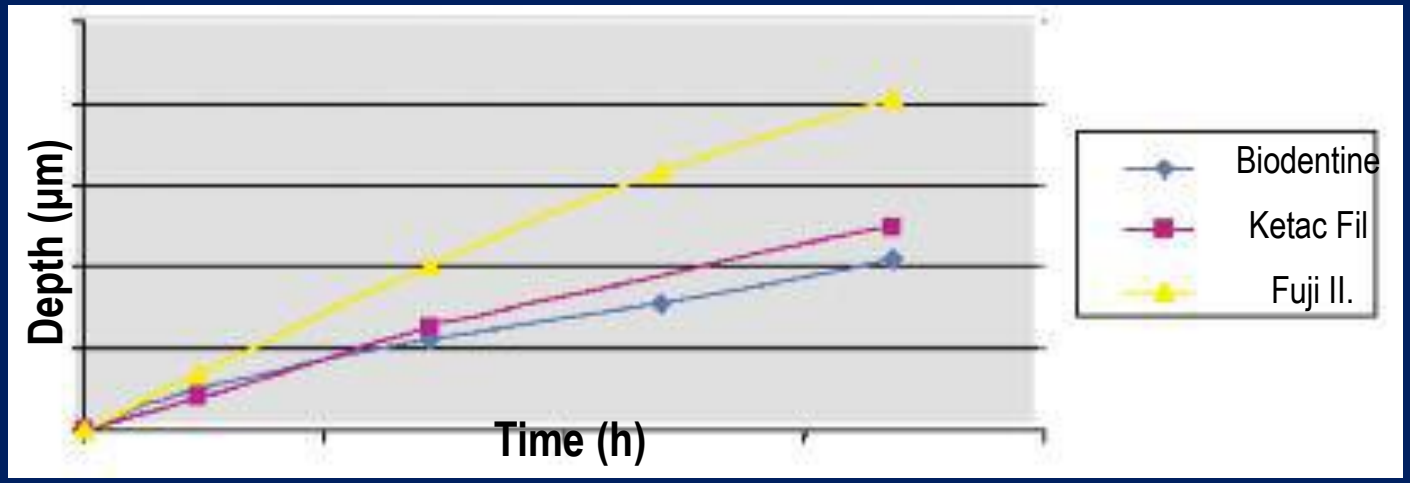
RADIOOPACITY

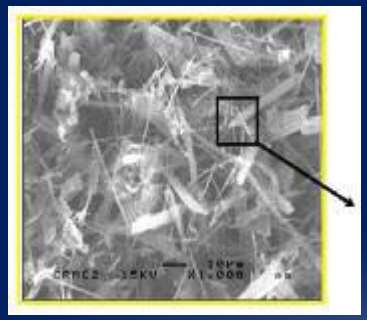
3.5 mm of aluminum. This value is over the minimum requirement of the ISO standard (3 mm aluminum). This makes Biodentine™ particularly suitable in the endodontic indications of canal repair.

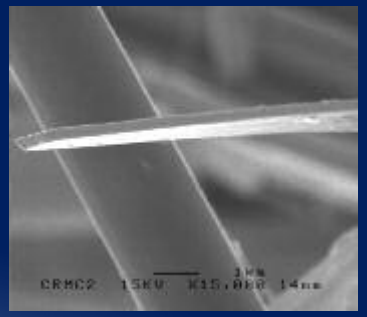
COMPARISON WITH GLASS IONOMERS AND PRO ROOT® MTA

It can be concluded that Biodentine™ has a mechanical behavior similar to glass ionomers and is also similar to natural dentine. The mechanical resistance of Biodentine™ is also much higher than that of ProRoot® MTA.

RESISTANCE TO ACID

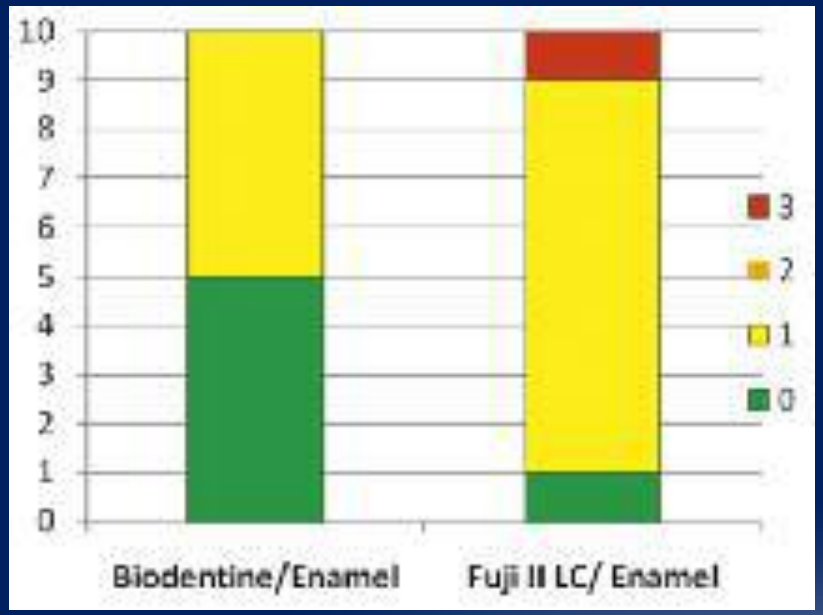


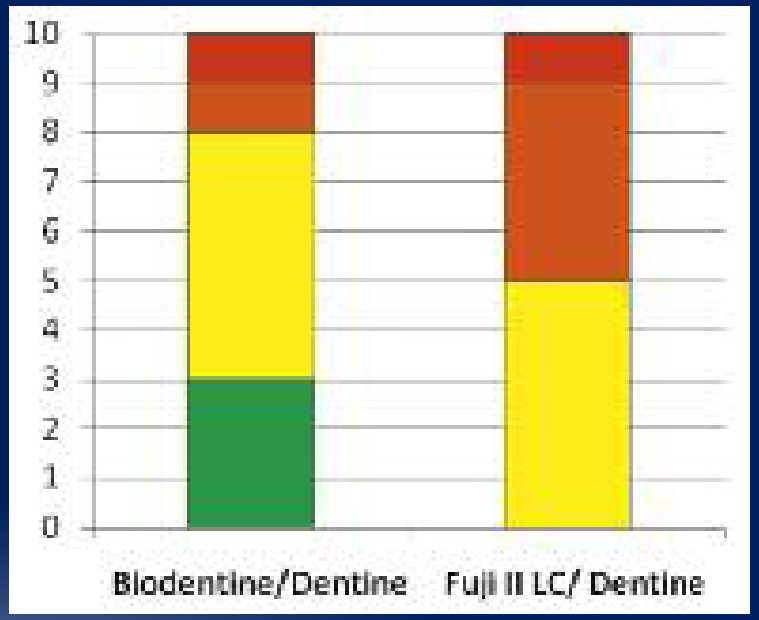




MICROLEAKAGE

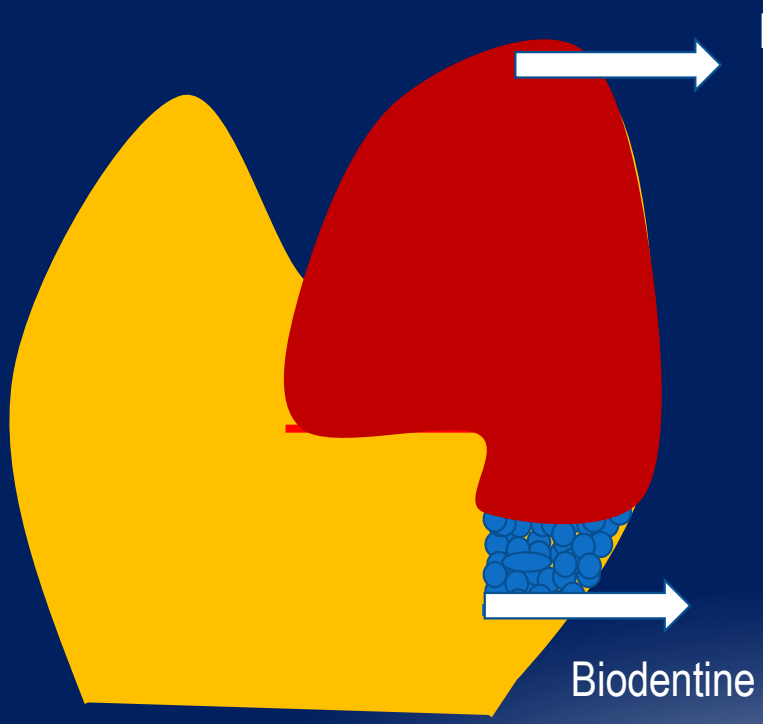
Leakage was evaluated separately, in contact with enamel or in contact with dentineBiodentine™ exhibits better leakage resistance both toenamel and to dentine compared to Fuji II LC.

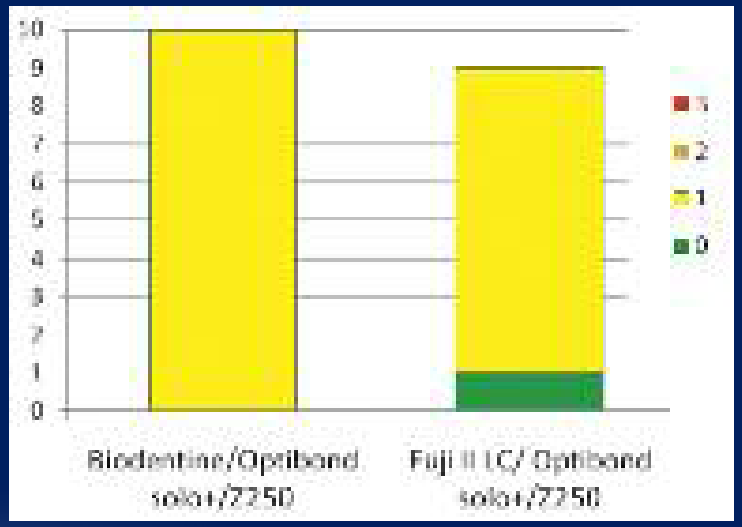




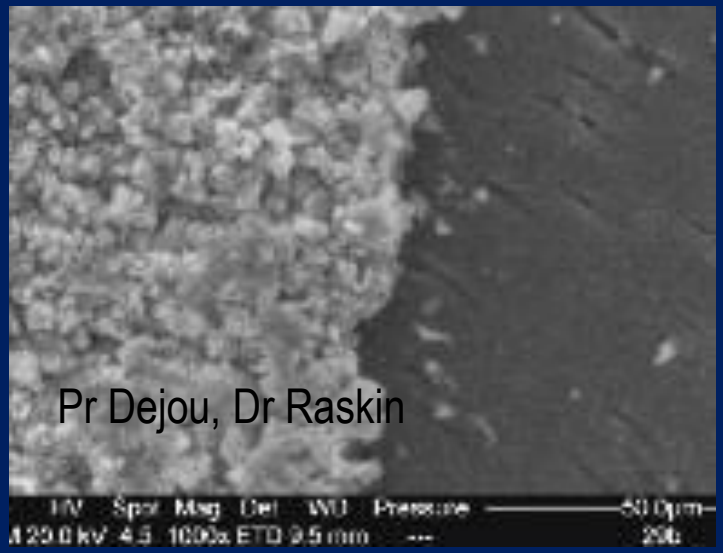
MICROLEAKAGE

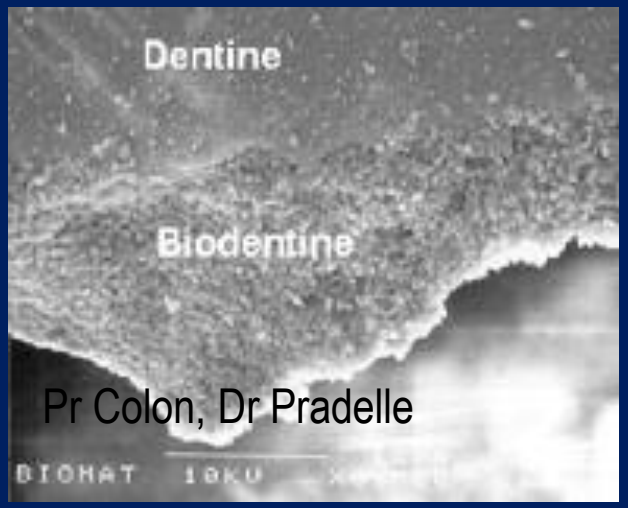
- Comparison to Fuji II LC (the combination with Optibond)

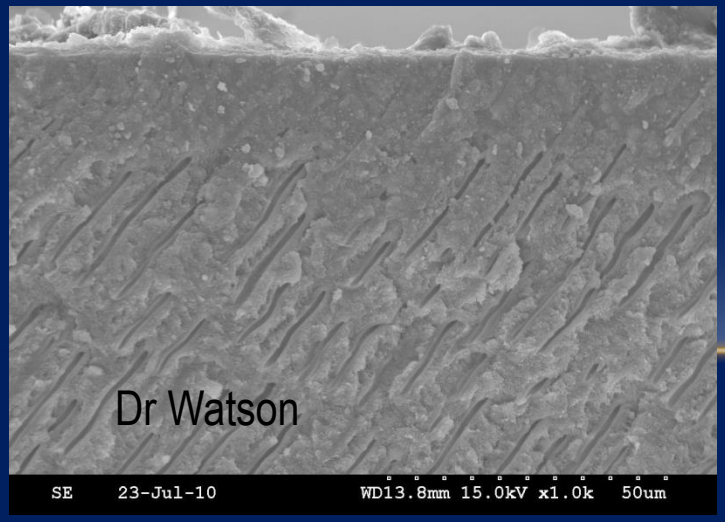


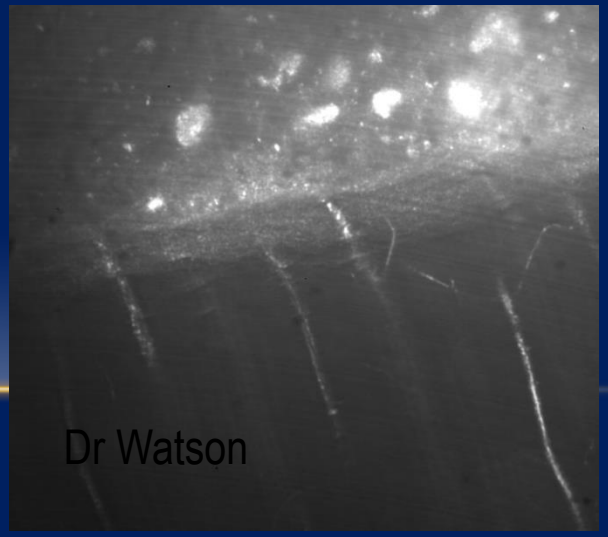


INTERFACES - BIODENTINE

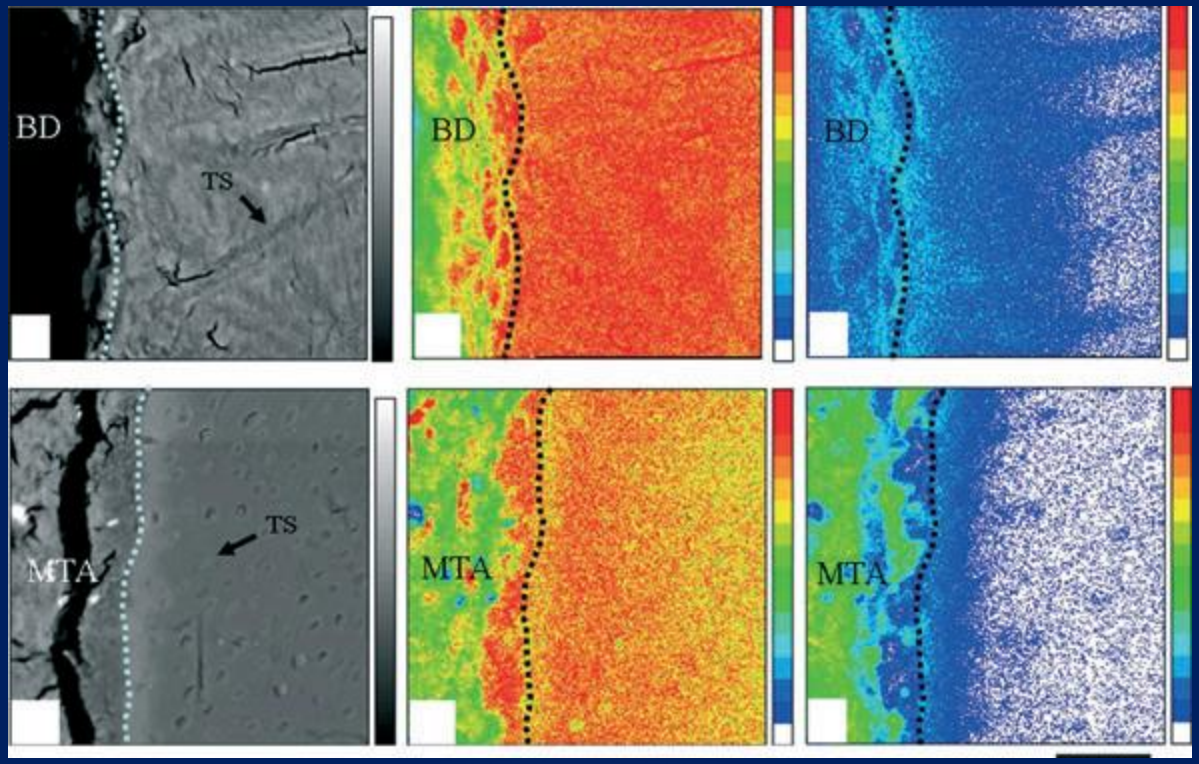




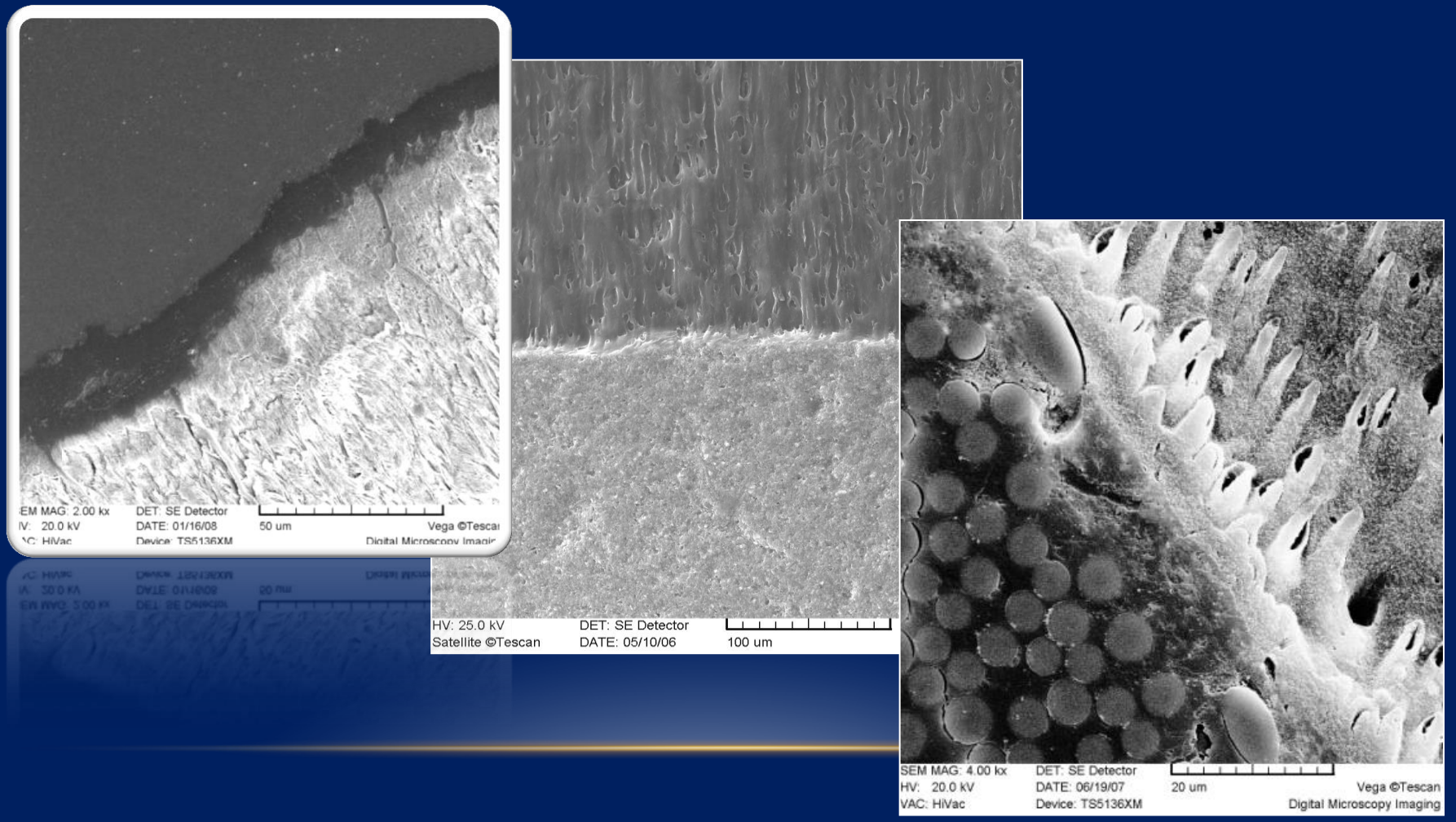




INTERFACE

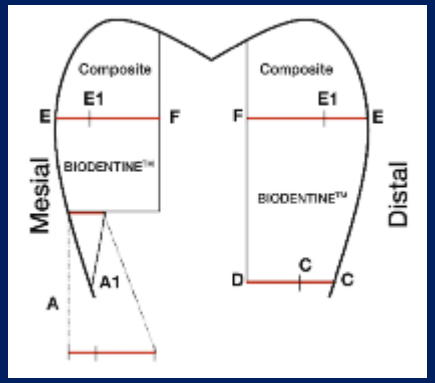


INTERFACES - COMPOSITE



MICROLEAKAGE

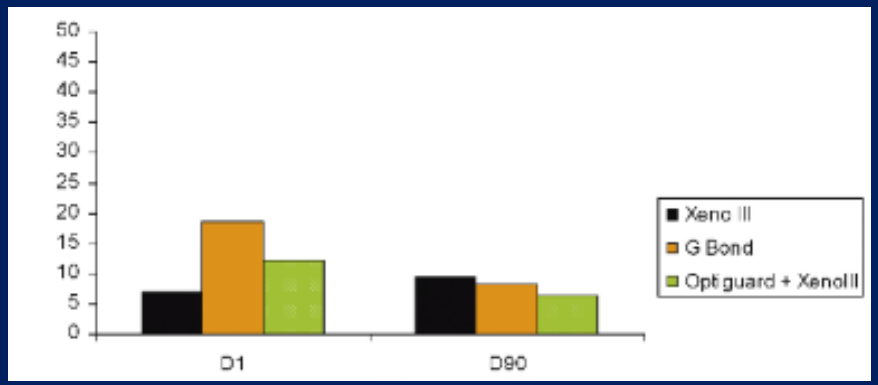
- Dye penetration
- At the enamel - BIODENTINE™ interface:
- % Dye penetration = (AA1/AB) * 100%
- • At the dentin - BIODENTINE™ interface:
- % Dye Penetration = (CC1/CD) * 100%
- • At the composite - BIODENTINE™ interface:
- % Dye Penetration = (EE1/EF) * 100%



MICROLEAKAGE

The interfaces which are developed between Biodentine™ and

the dental surfaces (enamel and dentine) as well as with adhesive systems (Xeno® III or G Bond), are very resistant to micro leakage, with or without pre-treatment by polyacrylic acid solutions. The choice of water based adhesive systems might be preferable.



BIOCOMPATIBILITY

Followed the guideline ISO 7405 – 2008

- **Cytotoxicity tests (ISO 7405, ISO 10993-5) – Biodentine, mTA, $Ca(OH)_2$**
- **Sensitization tests (ISO 7405, ISO 10993-1)**
- **Genotoxicity tests (ISO 7405, ISO 10993-3, OCDE 471)**
- **Cutaneous irritation tests (ISO 7405, ISO 10993-10)**
- **Eye irritation tests (OCDE 405)**
- **Acute toxicity tests (ISO 7405, ISO 10993-11,OCDE 423)**

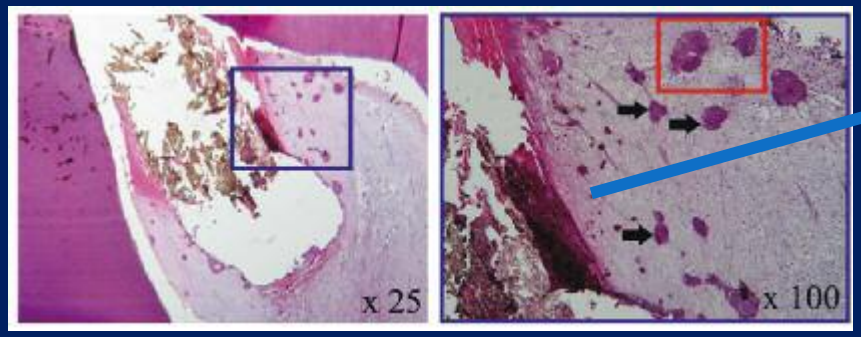
PRECLINICAL SAFETY CONCLUSION

In conclusion, Biodentine™ is safe.

Compared to well known dental materials such as Dycal® (calcium hydroxide), Biodentine™ exhibits less cytotoxicity. Moreover, when compared to ProRoot® MTA,Biodentine™ demonstrates at least equivalent biocompatibility.

BIOACTIVITY – IN VITRO PULP CAPPUNG

28 days



Dentine bridge

To conclude, Biodentine™ is able to stimulate initiation and development of mineralization.

BIOACTIVITY - ANGIOGENESIS

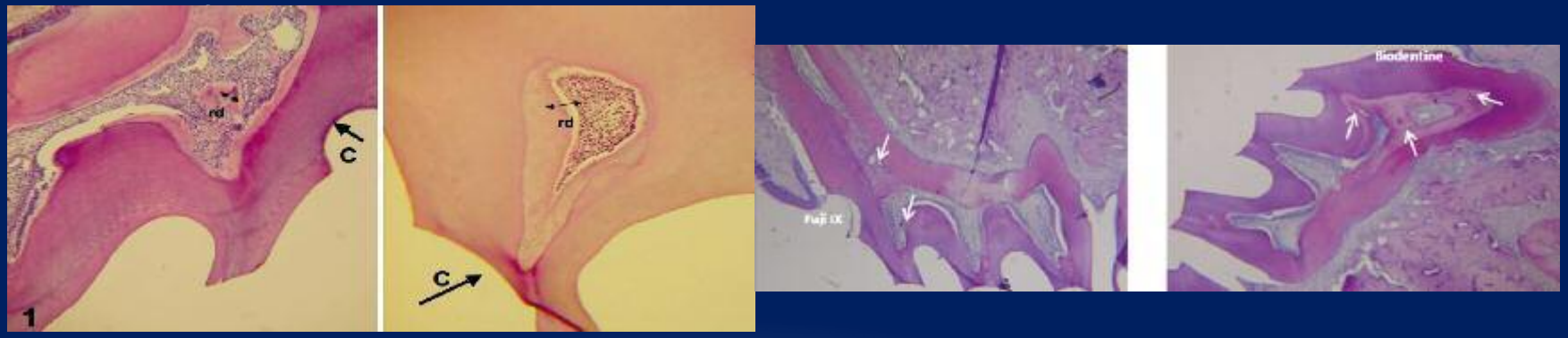
The concentration level of TGF-β1 was enhanced by both ProRoot® MTA and Biodentine™. Moreover, VEGF and FGF-2 were enhanced in presence of Biodentine™.

Biodentine™ is able to stimulate angiogenesis, in order to heal pulp fibroblasts.

BIOACTIVITY – INDIRECT PULP CAPPING

Biodentine™ was able to stimulate a reactionary dentine which is a naturalbarrier against bacterial invasions. The reactionary dentine formation stabilises at

3 months, indicating that the stimulation process is stopped when a sufficient dentine



Goldberg 2009

BIOACTIVITY – DIRECT PULP CAPPING AND PULPOTOMY

Biodentine™ is a suitable material for pulpotomy

12 weeks

and direct pulp capping

12 weeks

Biodentin is at least equivalent MTA, better than the others

OVERALL BIOACTIVITY

- Biodentin was well tolerated. Moreover, Biodentine™ was able to promote mineralisation, generating a reactionary dentine as well as a dense dentine bridge. These phenomena illustrate the great potential for Biodentine™ to be in contact to the pulp, by demonstrating its bioactivity in several indications.

As a conclusion, Biodentine™ is bioactive.

CLINICAL EFFIFACY

- **Biodentine™ can be used as dentine substite under the composite**
- **Biodentine™ is used as a direct pulp capping material**
- **Biodentine™ is used as an endodontic repair material**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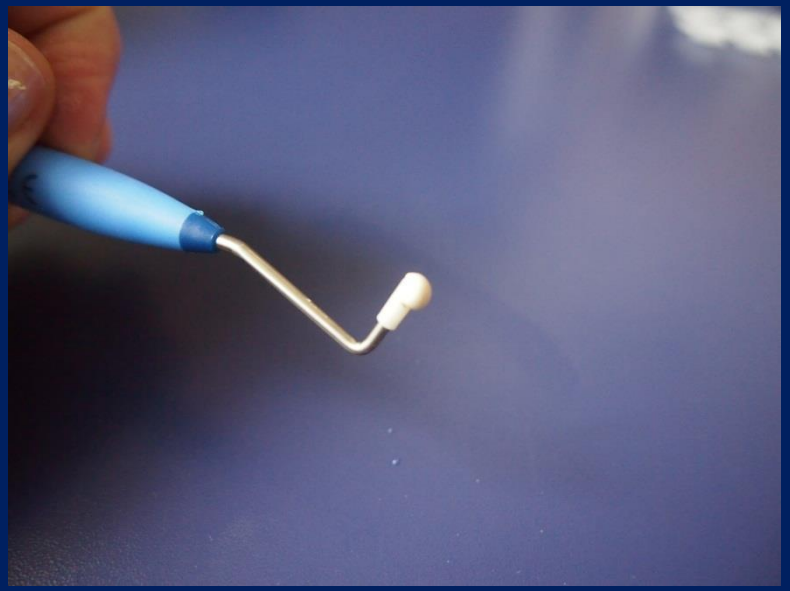
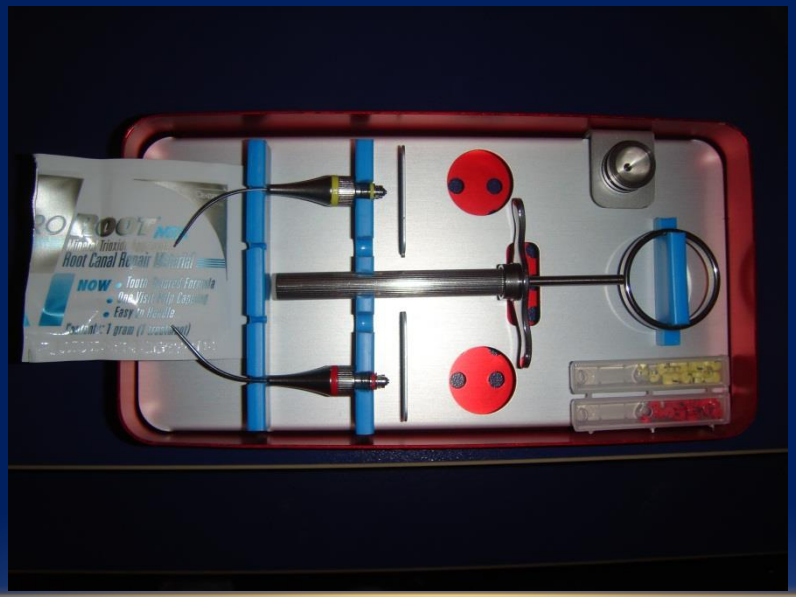


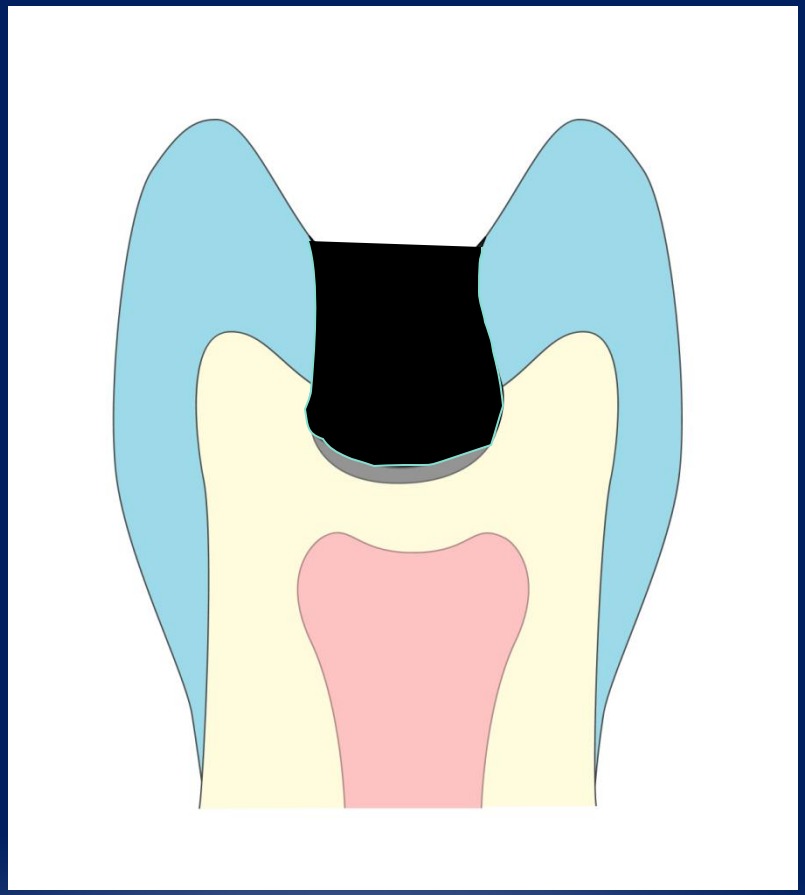


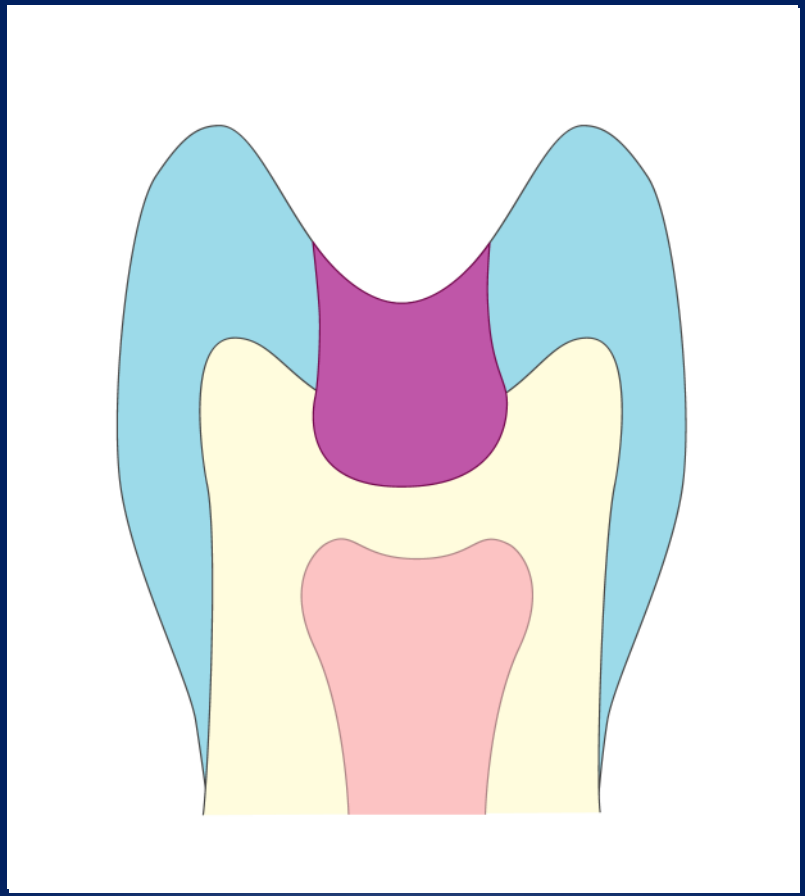
CLINICAL EFFIFACY

- **Biodentine™ can be used as dentine substite under the composite**

When and why?

ART





SUBSTITUTION OF DENTIN

Good connection to dentin and – bioactivity!!!!

Deep caries, perforation:

Direct and in direct pulp capping.

CLINICAL EFFIFACY

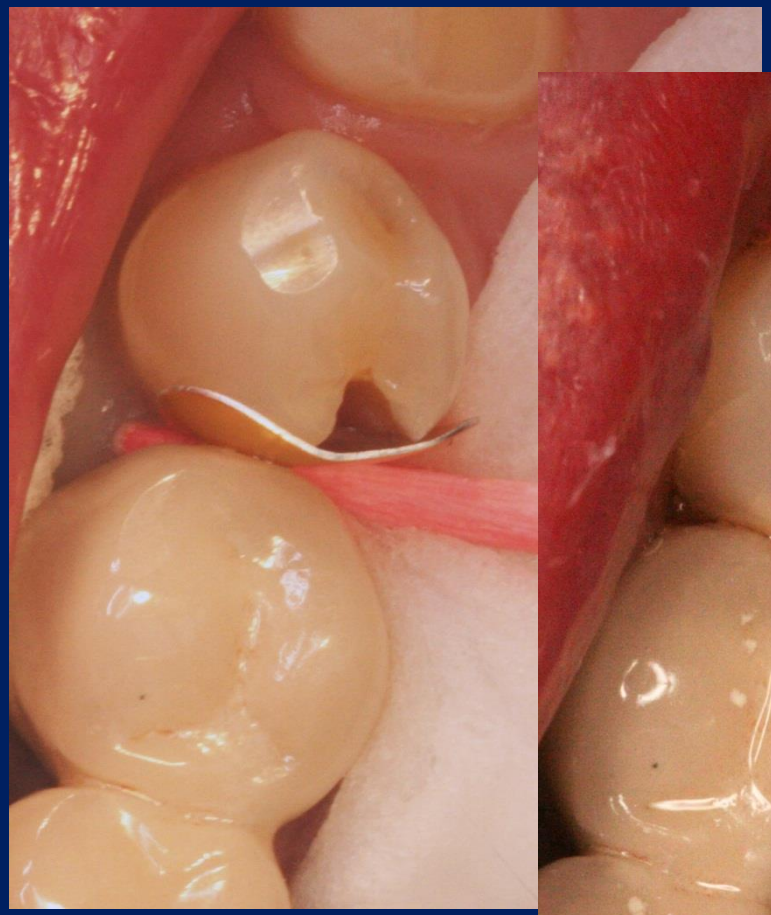
- **Biodentine™ is used as a pulp capping material**

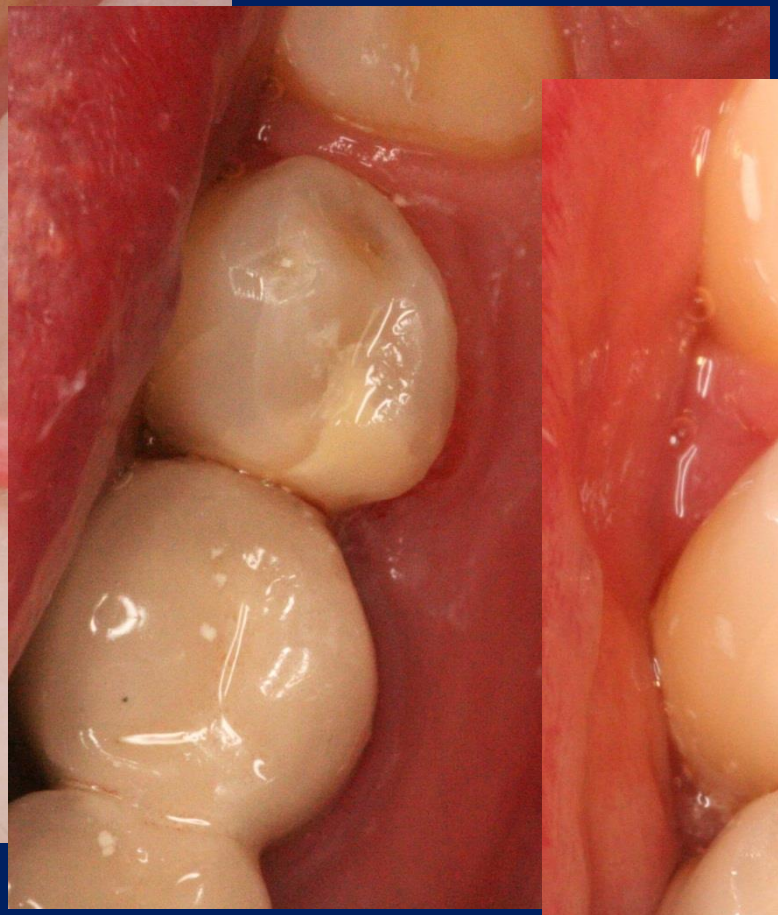
How much carious dentin can be left?
As small amount as possible, clean borders!

Bioactive material only!!!

Biodentine ™ after 5 month

After cleaning and overalyering with composite material

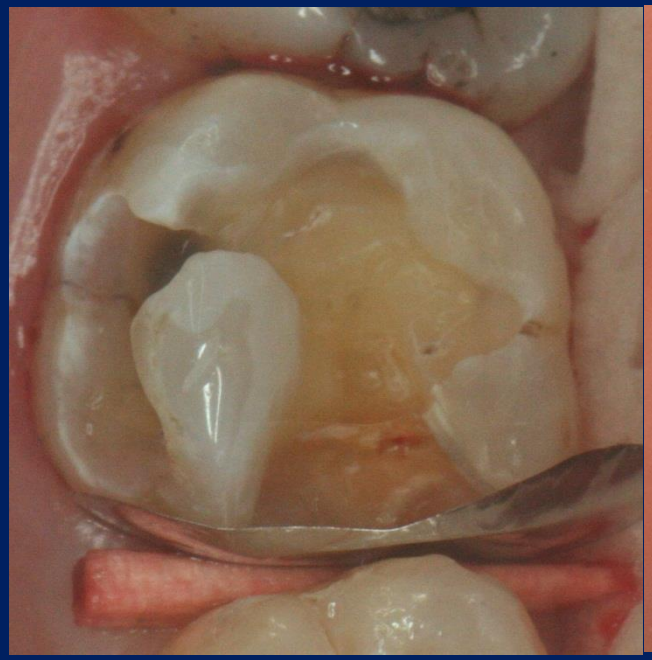




Pre Op

Post Op – Biodentine ™

Post Op – Composite material – 2 weeks later



Dry operating field is important!!!!
If possible use rubber dam!
It is posible to cover Biodentine ™ with a composite filling in the same session – selfetching adhesive systém (water content) can be recommended.
Redoing of composite part of the filling can be done after weeks or months.

Pulpotomy - deep caries.
Primary molars – no sign of pulpitis.
Before root resorption.

CLINICAL EFFIFACY

- **Biodentine™ is used as an endodontic repair material**
- **Perforation**
- **Apexification**
- **Resorption**



- Stop bleeding !
- Dry operating field !
- After setting root canal filling.

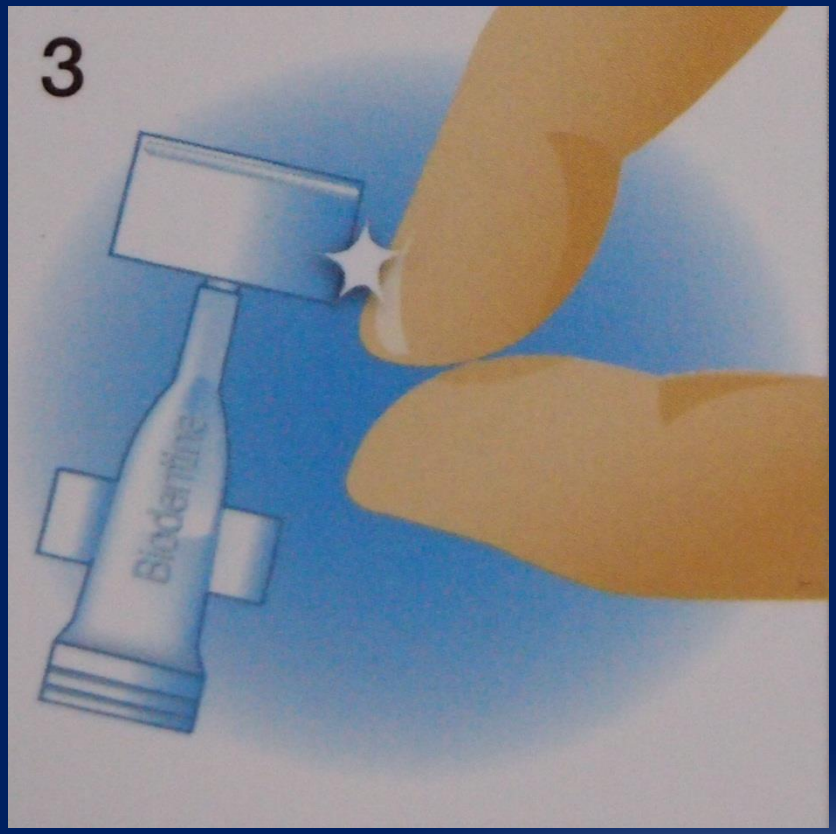


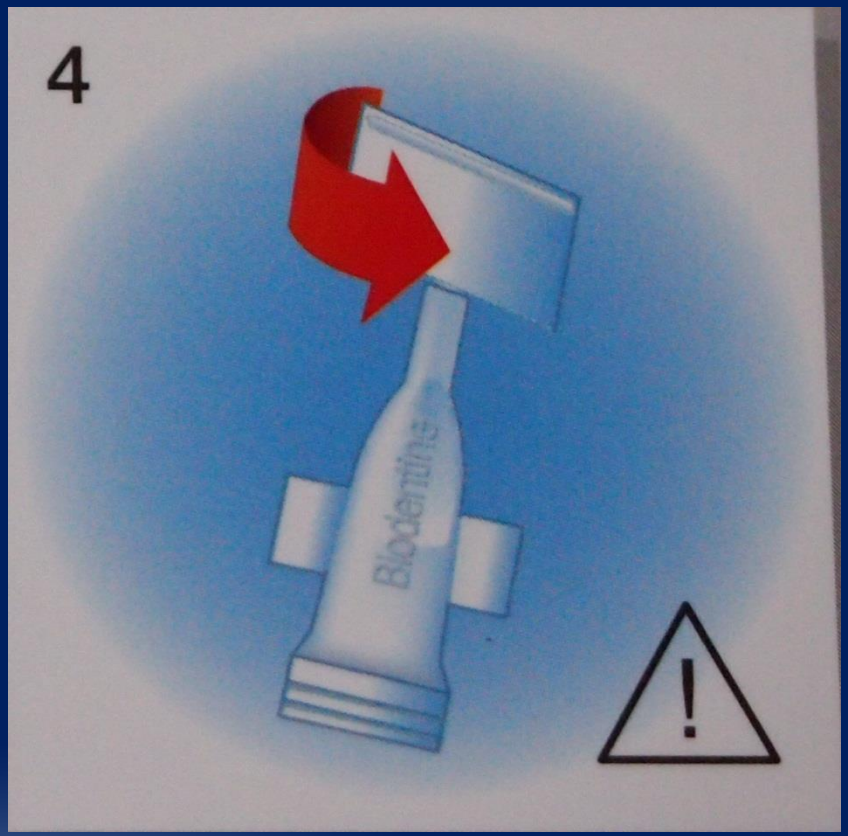
Find the perforation first!
Fill the root canal !
Fill the perforation.

CLINICAL GUIDE

CLINICAL GUIDE

CLINICAL GUIDE

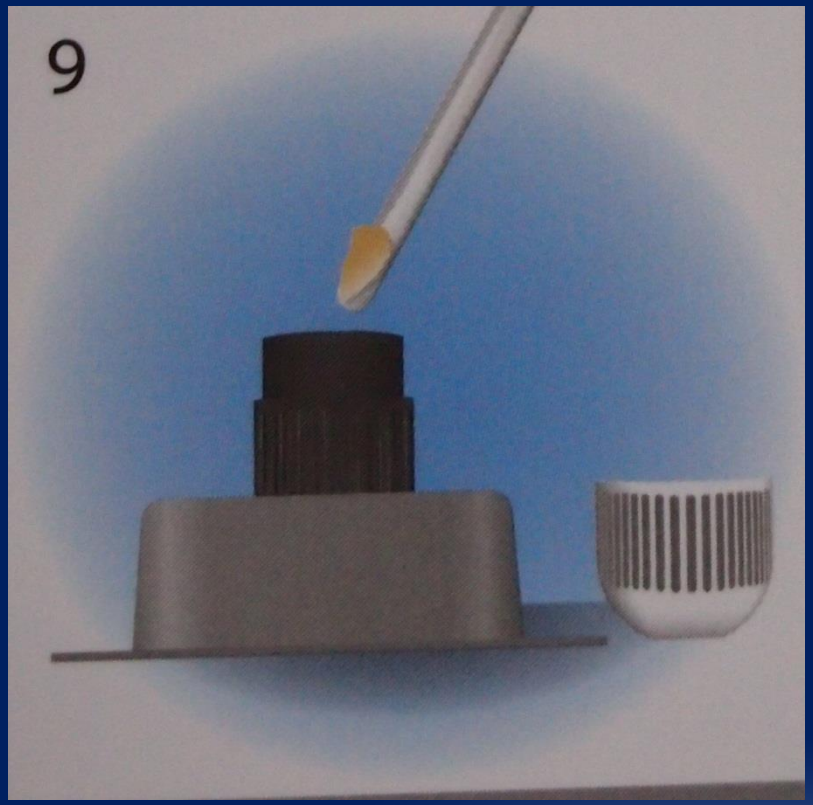


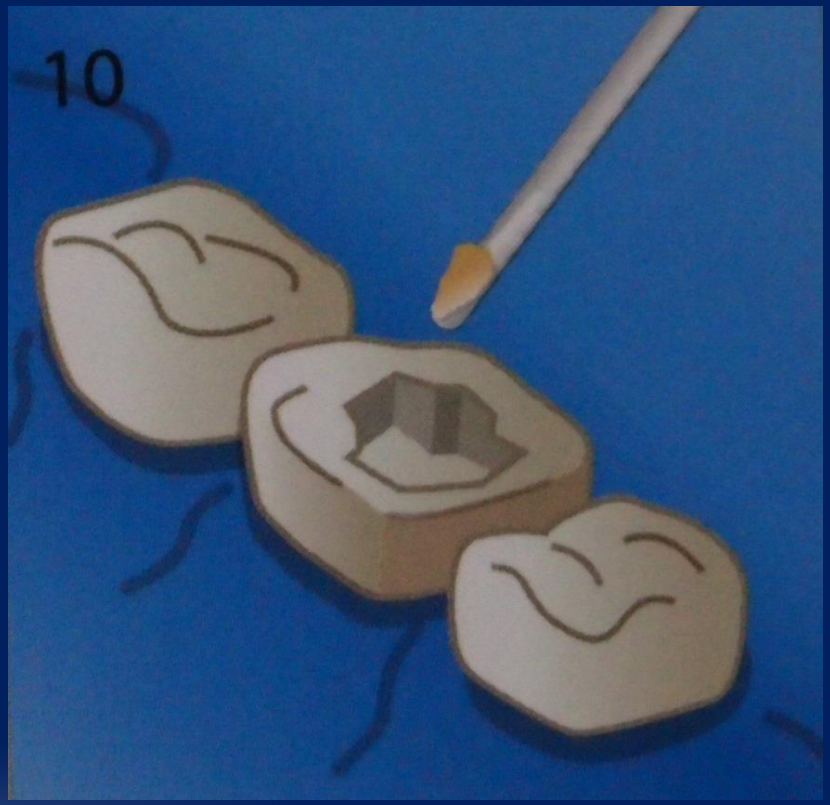


CLINICAL GUIDE

CLINICAL GUIDE

CLINICAL GUIDE





CLINICAL TIPS

- Use metal or plastic instruments - spatulas, amalgam gun or MTA gun.
- If material is too runny – wait.
- If material is too hard – chceck if all liquid has been poured into the capsule, if yes – re.mix 10 s.
- Material is too slumpy – it is not sculptable – wait, do not overwork it – crystal structure can be destroyed and it prevents setting.
- 12 min is too long? Min working time, 6 min setting time in oral cavity.

CLINICAL TIPS

- Trimming is not necessary, at the end of the setting it is possible to shape the material do not overwork the material.

- Matrix removal – at the end of the setting time, it can be treated with vaseline or orange solvant.

- Patints should be advise to be careful forst hours (they should avoid liquids which are too hot, too cold, too acid. The staining is on the surface.

- Second visit – the surface layer should be removed using red coded (fine) diamond bur.

REFERENCES

- Scientific File – Septodont

Others scientific papers:

Biodentine™ induces TGF-β1 release from human pulp cells and early dental pulp mineralization

P. Laurent1, J. Camps1, I. About1,2
1: Laboratoire Interface Matrice Extracellulaire Biomatériaux (IMEB), Faculté d'Odontologie, Université de la Mediterranée;and
2: Institut des Sciences du Mouvement UMR 6233, Université de la Méditerranée et CNRS, Marseille, France
Article first published online: 22 DEC 2011 DOI: 10.1111/j.1365-2591.2011.01995.x

Biodentine™ Scientific file

Uptake of calcium and silicon released from calcium silicate–based endodontic materials into root canal dentine

L. Han & T. Okiji
Division of Cariology, Operative Dentistry and Endodontics, Department of Oral Health Science, Niigata University Graduate School
of Medical and Dental Sciences, Niigata, Japan
IEJ doi:10.1111/j.1365-2591.2011.01924.x

Quantitative Evaluation by Glucose Diffusion ofMicroleakage in Aged Calcium Silicate-Based Open-Sandwich Restorations

S. Koubi,1, 2 H. Elmerini,1, 3 G. Koubi,1, 2 H. Tassery,1, 2 and J. Camps1, 4

International Journal of Dentistry

Volume 2012, Article ID 105863, 6 pages

doi:10.1155/2012/105863

Dentin-cement Interfacial Interaction: Calcium Silicates and Polyalkenoates

A. R. Atmeh, E. Z. Chong, G. Richard, F. Festy and T. F. Watson

B. J DENT RES published online 20 March 2012

http://jdr.sagepub.com/content/early/2012/03/20/0022034512443068

Clinical evaluation of the performance and safety of a new dentine substitute, Biodentine, in the restoration of posterior teeth — a prospective study

Gilles Koubi & Pierre Colon & Jean-Claude Franquin & Aline Hartmann & Gilles Richard & Marie-Odile Faure & Grégory Lambert

Clin Oral Invest

DOI 10.1007/s00784-012-0701-9