

BIOCERAMIC MATERIALS IN ENDODONTICS

*Rok Jurič, DMD, FICD, endodontist
doc. dr. Tomislav Jukić, DMD, FICD*

*17. Quintessence International Congress
Zagreb, 21st of October, 2017*

Primary functions of a root canal filling

- *stop coronal leakage*
- *prevent apical leakage*
- *entomb surviving MO in root canal*

*Sundqvist G, Figdor D. Endodontic treatment of apical periodontitis.
In: Orstavik D, Pitt Ford TR, eds. Essential endodontology. Prevention and treatment of apical periodontitis.
Oxford: Blackwell, 1998.*

10

Obturation requirements

Commandments

1. *is easily introduced into the canal*
2. *seal the canal laterally and apically*
3. *do not shrink*
4. *is impervious to moisture*
5. *is bacteriostatic*
6. *is radioopaque*
7. *do not stain tooth structure*
8. *do not irritate periapical tissues*
9. *is sterile or able to be sterilised*
10. *is easily removed from the canal*

Grossman LI, 1936

1. *I am the LORD your God*
2. *You shall not take the name of the LORD in vain*
3. *Remember to keep holy the LORD'S Day*
4. *Honor your father and mother*
5. *You shall not kill*
6. *You shall not commit adultery*
7. *You shall not steal*
8. *You shall not bear false witness against your neighbour*
9. *You shall not covet your neighbour's wife*
10. *You shall not covet your neighbour's goods*

God to Moses on Sinai mountain, 1300 BC

Endodontic filling materials

CORE MATERIALS

- *gutta-percha cones*
- *resin cones* (Resilon)

SEALERS

- *ZnO-eugenol* (Roth, ProcoSol)
- *resin*
 - *epoxy* (AH 26, AH plus)
 - *methacrylate* (EndoRez, RealSeal)
- *glass ionomer* (KetacEndo)
- *silicone* (RoekoSeal, GuttaFlow)
- *Calcium hydroxide* (Apexit, Sealapex)
- *bioceramic*
 - *Ca-Si* (MTA, Biodentin, BioRoot RCS)
 - *Ca-Si-P* (TotalFill, Bioaggregate)

Tests for filling materials (ISO, ASTM)

○ PHYSICO-CHEMICAL PROPERTIES

- *setting time (initial (working)/final)*
- *mechanical strength (compressive, flexural, push-out) and hardness*
- *dimensional stability (-1%..+0.1%)*
- *porosity*
- *solubility (<3%)*
- *flow (>20mm)*
- *radiopacity (>3mm Al)*

○ BIOLOGICAL PROPERTIES

- *cytotoxicity*
- *terato-, canbero-, mutagenicity*

*Wang Z. Endod Topics 2015; 32: 3-30.
Shen Y et al. Endod Topics 2015; 32: 47-85.*

Clinically important properties of filling materials

PHYSICO-CHEMICAL PROPERTIES

- *dimensional stability (contraction, expansion)*
- *solubility (inert/bioactive)*
- *adhesion*

BIOLOGICAL PROPERTIES

- *biocompatibility*
- *biomineralization*
- *induction of odonto-/osteoblast differentiation*
- *antibacterial activity*

HANDLING PROPERTIES

- *viscosity (low/high)*
- *setting time (slow/fast)*
- *radiopacity (low/high)*
- *removal ability*

Orstavik

Table 3: Physical properties of endodontic materials

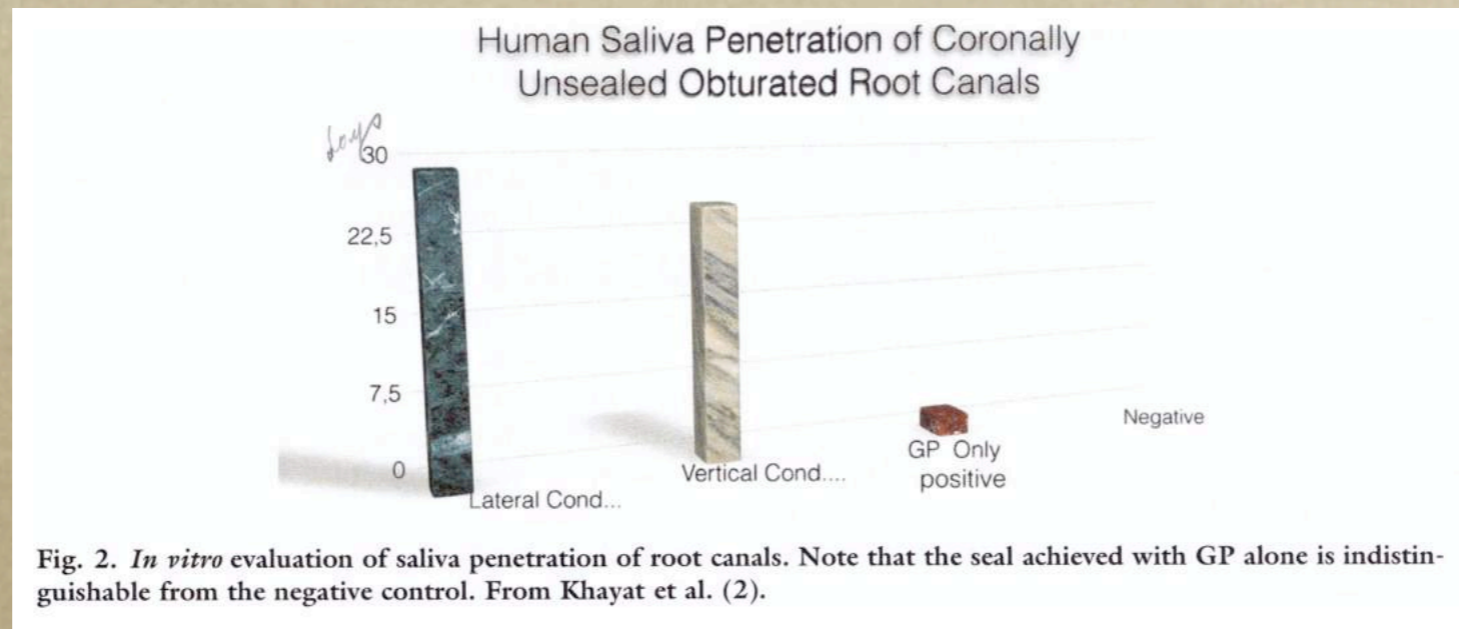
Material	Subgroup	Dimensional stability (%)	Adhesion (MPa)	Solubility (%)
ZnO-eugenol	Zn chelate	0-1	0.2-3	0.07
Resins	epoxy	-0.03 to +4	2.6-4.7	0.06-0.7
	methacrylate	8.1-10.1	2.7-3.0	3.4-12.8
Ca(OH) ₂	salicylate	~1.7	0.1-1.2	4.4
Silicone	sealer	0.3-0.4	0.2-0.7	-0.3 to +0.5
Ceramic	Ca-Si	<±0.1	0.5-6	1.1
	Ca-Si-P	0.09	1.5-3	2.9
	Ca-S-O	15?		~7.5

Table 4: Sealing ability and dentin tubule penetration of endodontic materials

Material	Subgroup	Sealing ability	Tubule penetration
ZnO-eugenol	reinforced	+?	?
	sealer	+?	~100 um
Resins	epoxy	+?	~500-1400 um
	methacrylate	+?	~900-1200 um
Ca(OH) ₂	salicylate	+?	~500-700 um
Silicone	sealer		~100-500 um
Ceramic	Ca-Si	+	-
	Ca-Si-P	±?	?
	Gypsum	+	

Note: Values may be found outside those listed, testifying to

Effectiveness of root filling techniques



- *lateral condensation* (oval canal / round cones, lateral condensation forces)
- *vertical condensation* (shrinkage of gutta-percha when it cools, vertical compaction forces, larger taper of preparation needed)

Khayat A, Lee SJ, Torabinejad M. J Endod 1993; 19: 458-461.

BIOCERAMICS

ceramic materials designed for use in medicine and dental medicine

- *diverse group of biocompatible materials, that is bioinert / bioactive / biodegradable*
- *use in medicine: orthopedic surgery (endoprotheses), bone surgery (bone fillers)*
- *use in dental medicine:*
 - *prosthodontics (alumina / zirconia ceramics)*
 - *oral surgery and periodontology (bone fillers - bioactive glass, HA)*
 - *endodontology:*
 - *pulp capping, pulpotomy (MTA, Biodentin)*
 - *root perforation, internal / external resorption (MTA, Biodentin)*
 - *retrograde filling in surgical endodontics (MTA, Biodentin)*
 - *orthograde root canal filling (BioRoot RCS, TotalFill)*

Oblak Č, Jevnikar P, Kosmač T. Zdrav Vestn 2013; 82: 825-36.

Trope M, Bunes A, Debelian G. Endod Topics 2015; 32: 86-96.

Bioceramics and their clinical applications. Kokubo T ed. Cambridge: Woodhead publ. 2008.

Genesis of bioceramics in endodontics

- **1. generation: ProRoot MTA (W/G)** Dentsply Maillefer
 - 75 % Portland cement (Ca_3Si , Ca_2Si , Ca_3Al , Ca_4AlFe), 20% Bi_2O_3 , 5% $CaSO_4$
- **2. generation: MTA Angelus** Angelus Dental Products
 - no $CaSO_4$
- **3. generation: EndocemZr** Maruchi
 - Bi_2O_3 replaced with ZrO_2 ali Ta_2O_5
- **4. generation: Biodentine, BioRoot RCS** Septodont
 - gel-sol technology - Ca_3Si , Ca_2Si , no Al, Fe
 - hydrophilic polymer, accelerator $CaCl_2$
- **5. generation: TotalFill BC (RRM putty, RRM syringe, RRM FS putty, sealer)** FKG
 - $Ca(H_2(PO_4)_2)$ - Ca phosphate monobasic, SiO_2 - colloid silica
 - premixed in syringe / jar

Bioceramic sealers

PHYSICO-CHEMICAL PROPERTIES

- *dimensional stability* - expansion +0,2%
- *setting in humid environment* (hydraulic cement)
- *solubility* - at mixing 2%, after 4 weeks insoluble (bioactivity via Ca^{2+} and OH^-)
- *adhesion to dentine* - biomineralization via CaHA and ettringite

Bioceramic sealers

BIOLOGICAL PROPERTIES

- **biocompatibility** - biomineralisation, induction of odontoblasts, osteoblasts and cementoblasts differentiation
- **antibacterial effect** - pH=12 up to 4 weeks after mixing

Shen Y et al. Endod Topics 2015; 32: 47-85.

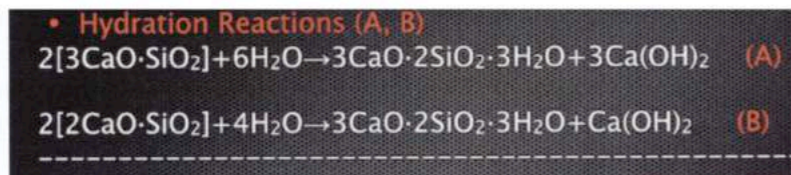


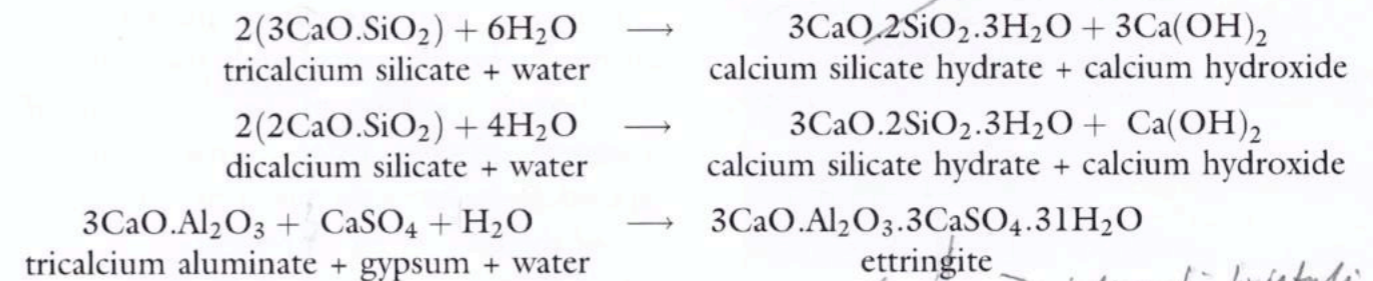
Fig. 5. Hydration reaction of bioceramic material in contact with water.



Fig. 6. Precipitation reaction of the Bioceramic.

90

Ca OH
Ca hydroxide



Ca 5 hydrogel

isometric kristali

Trope M, Bunes A, Debelian G. Endod Topics 2015; 32: 86-96.

Camilleri J. Int Endod J 2007; 40: 462-470.

Bioceramic sealers

WORKING PROPERTIES

- **viscosity** - suitable for intracanal application
- **setting time** - working time 30 min, final setting time 24h or more (humidity)
- **radiopacity** - suitable, but lower than MTA or AH plus

Khalil I, Naaman A, Camilleri J. J Endod 2016; 42: 1529-1535.

Xeureb M, Vella P, Camilleri J et al. J Endod 2015; 41: 111-124.

- **removal from the root canal** - difficult

Boutsioukis C, Noula G, Lambrianidis T. J Endod 2008; 34: 1239-1242.

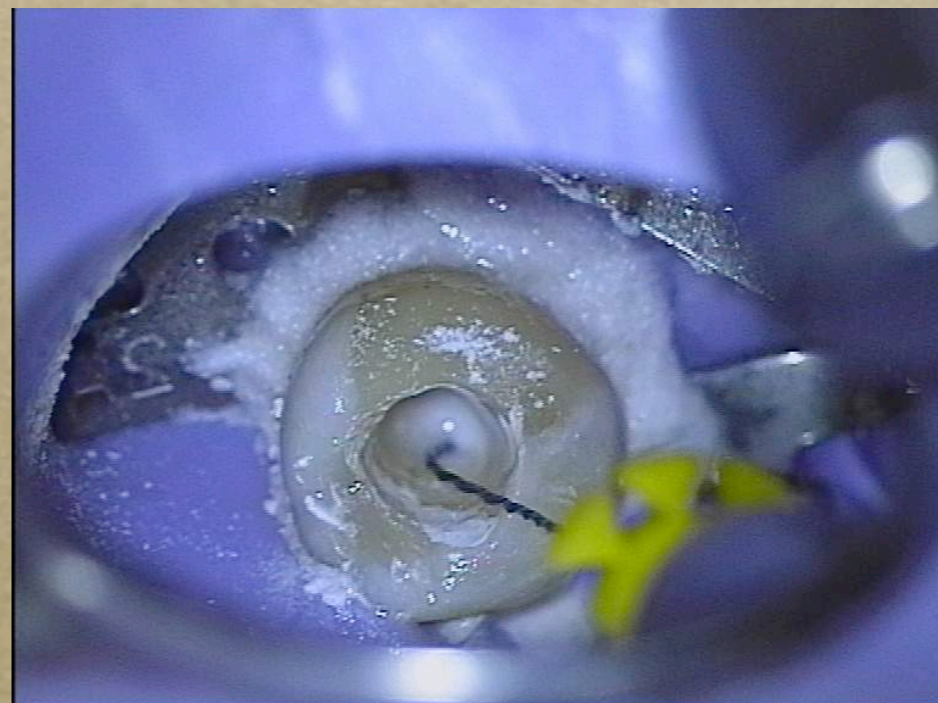
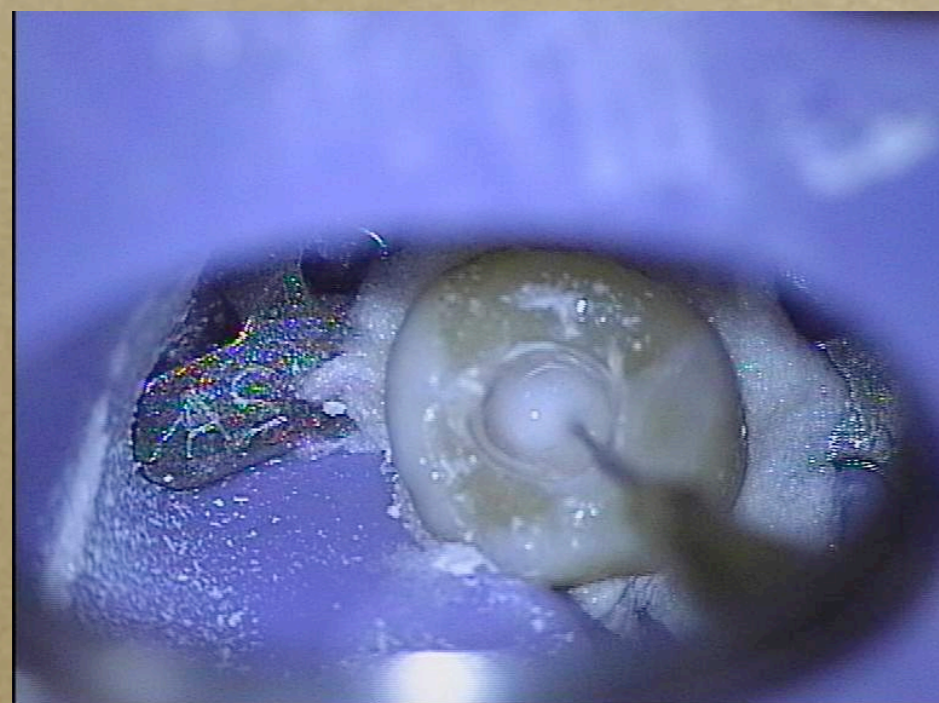
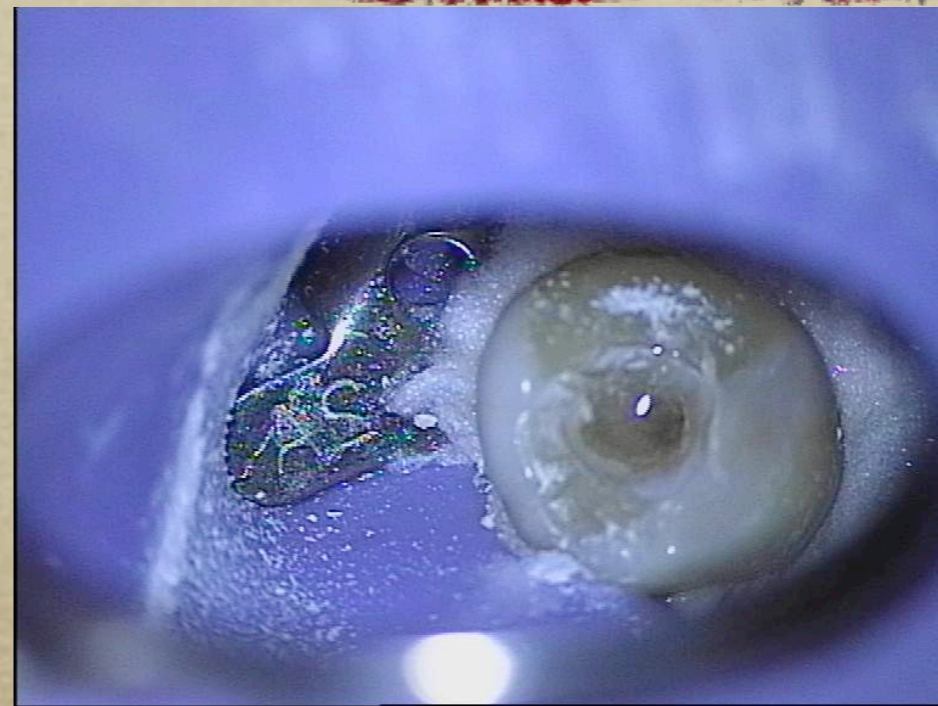
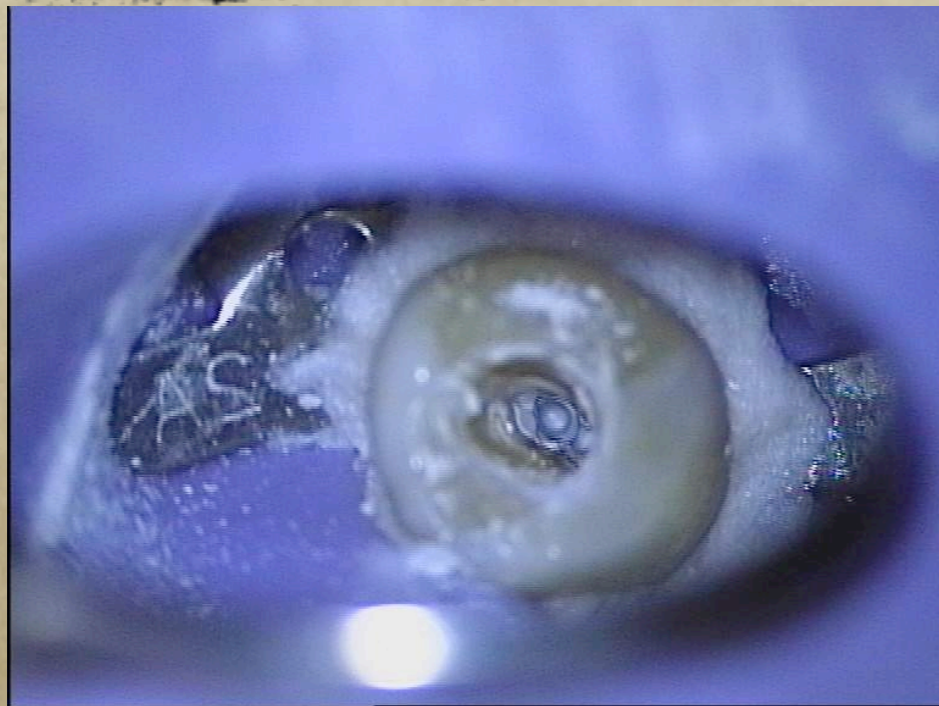
Clinical use of bioceramic sealer

TotalFill BC_{FKG}

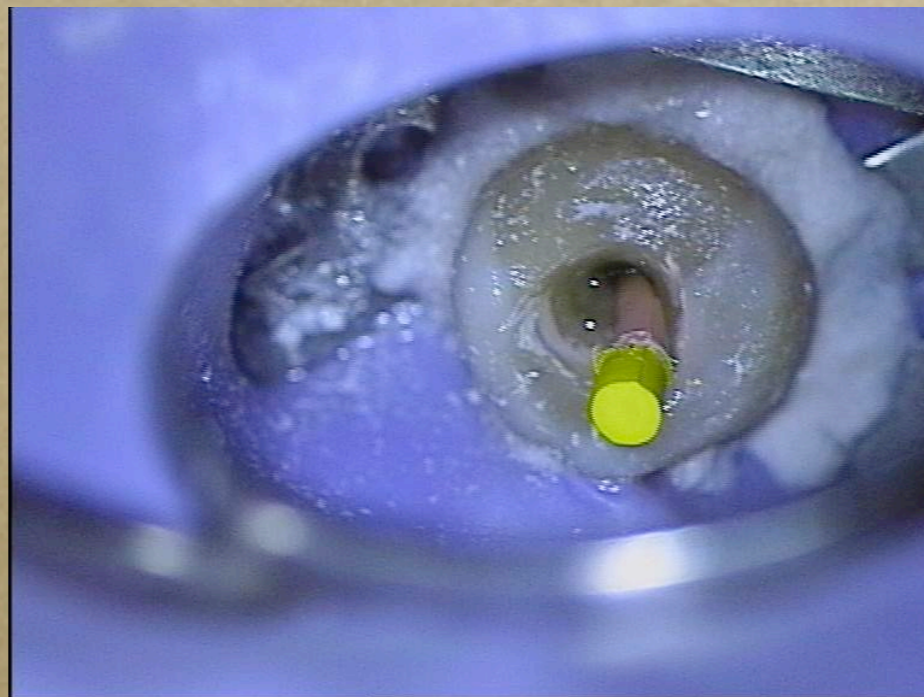
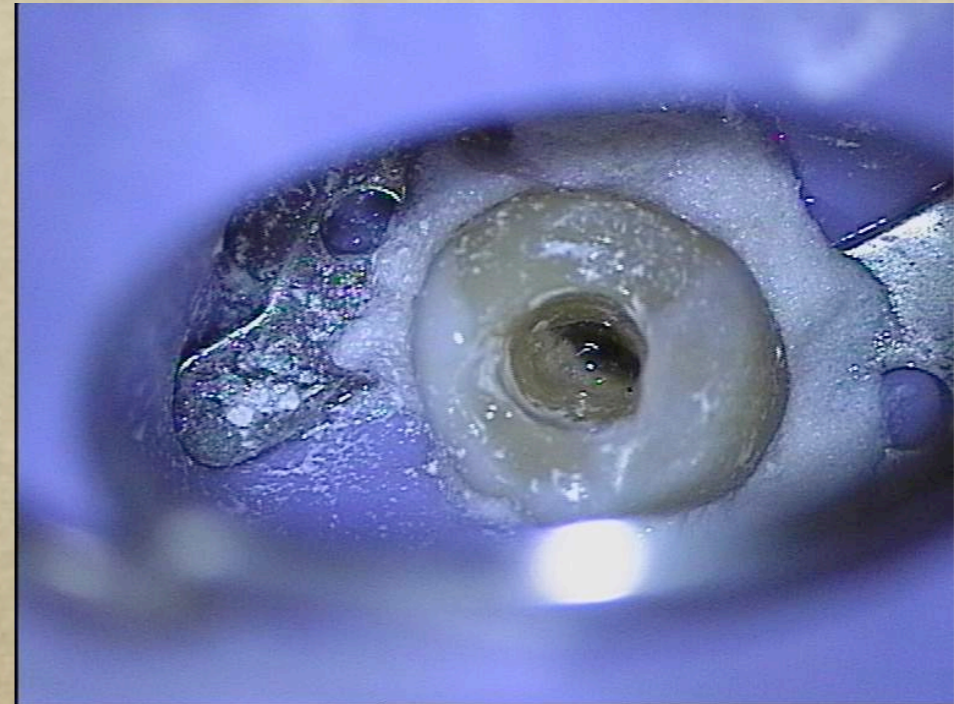
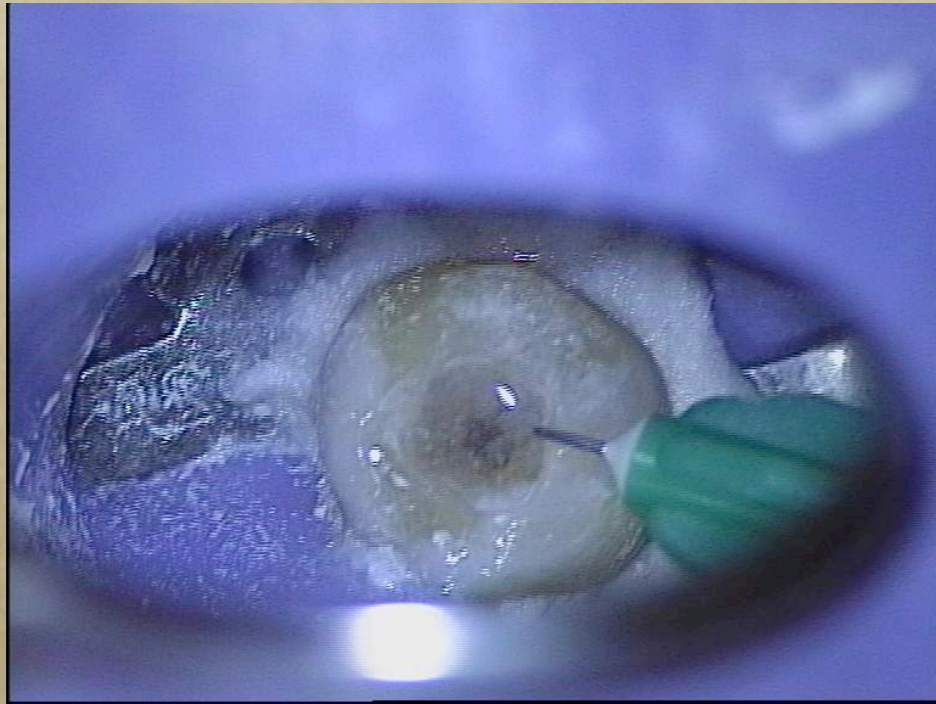
- *TotalFill BC Sealer (luer lock syringe + single use applicator)*
- *TotalFill Gutta-percha, impregnated and coated with bioceramic nano particles*



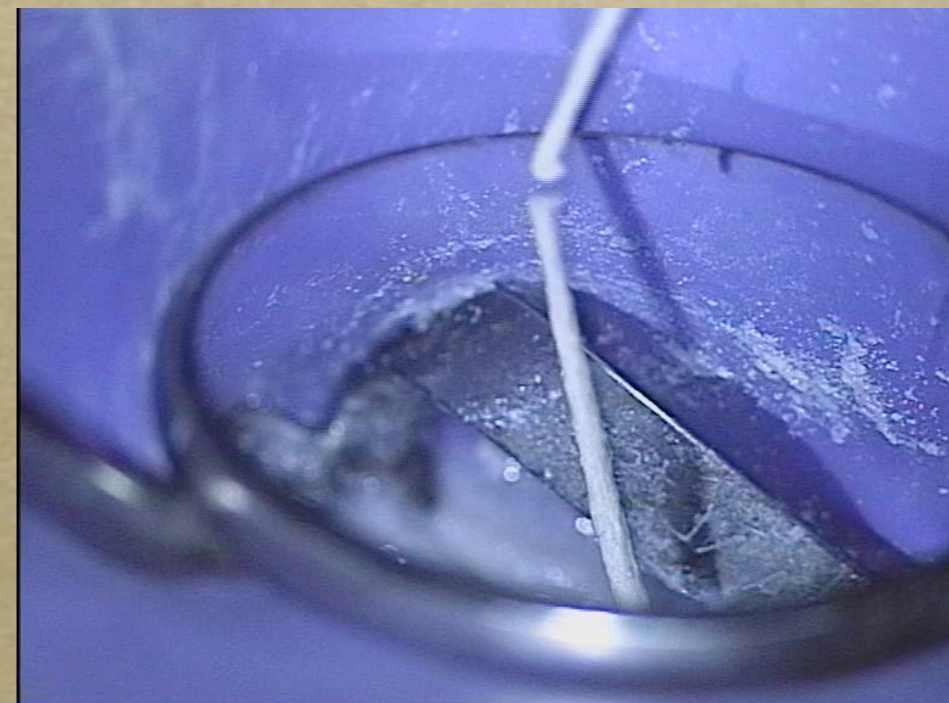
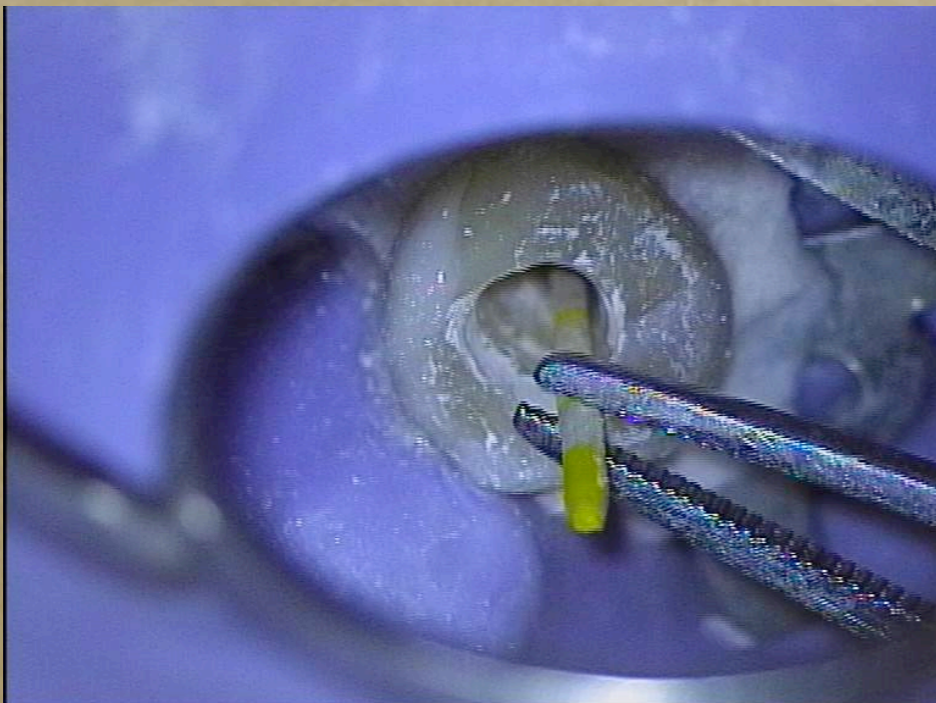
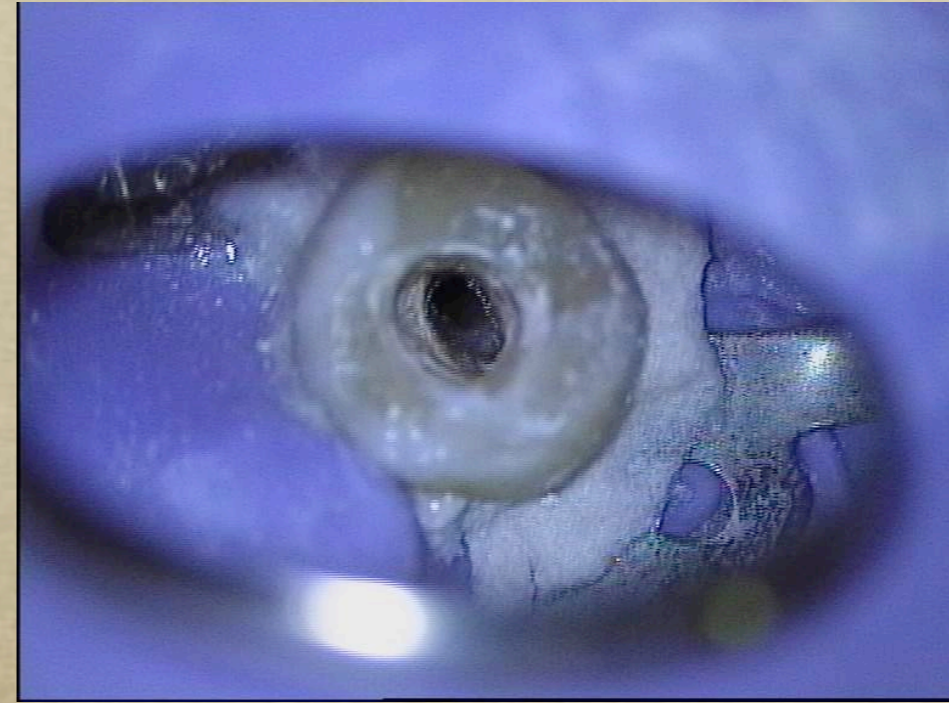
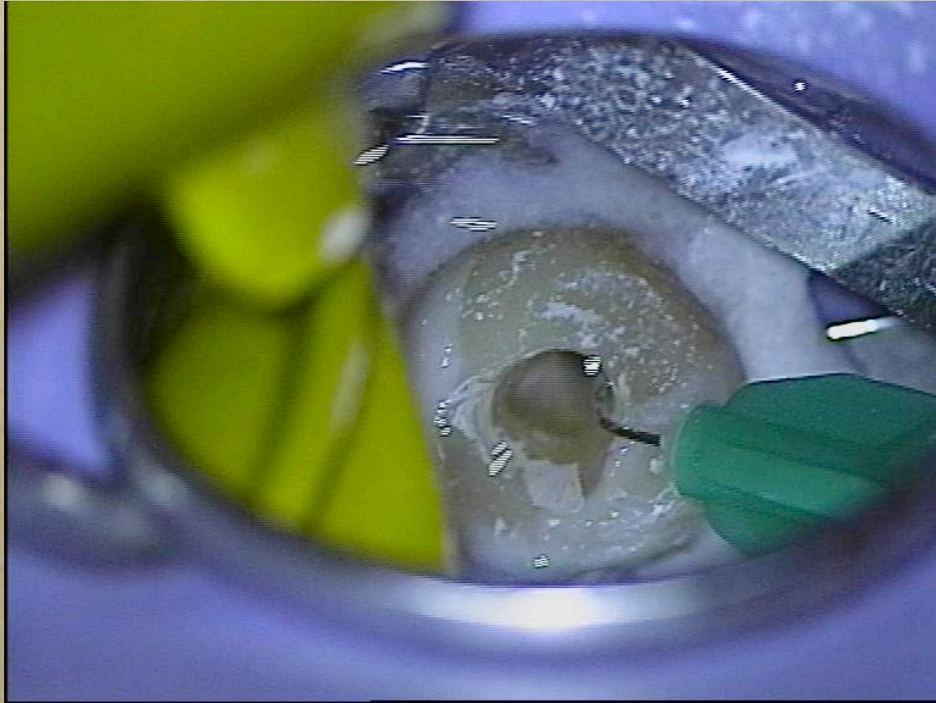
TotalFill BC
IRRIGATION
NaOCl, IrriSafe, XPF



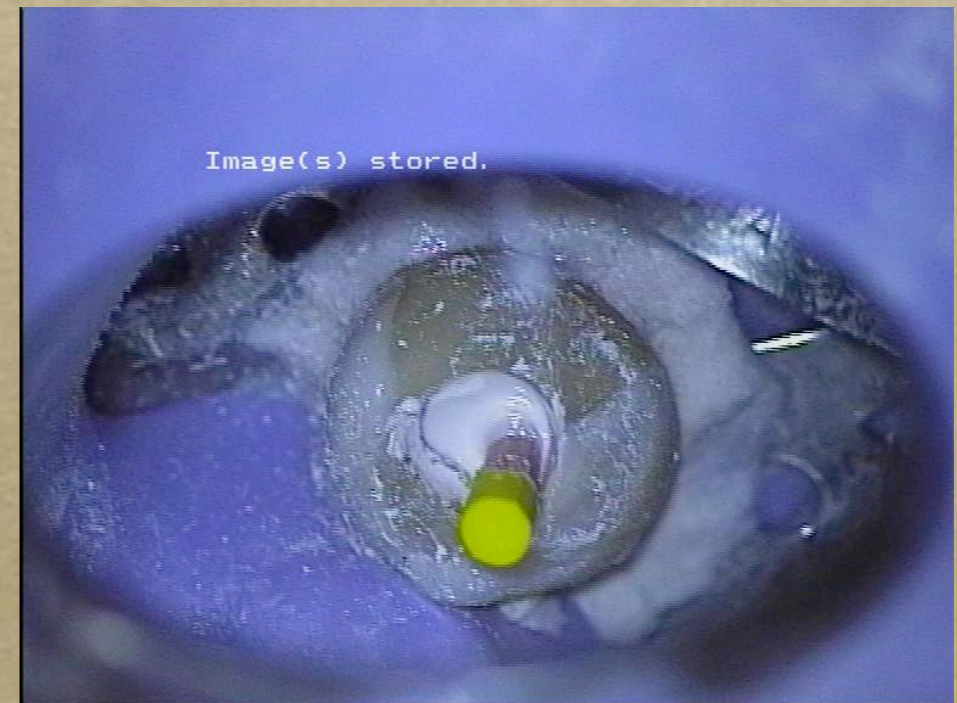
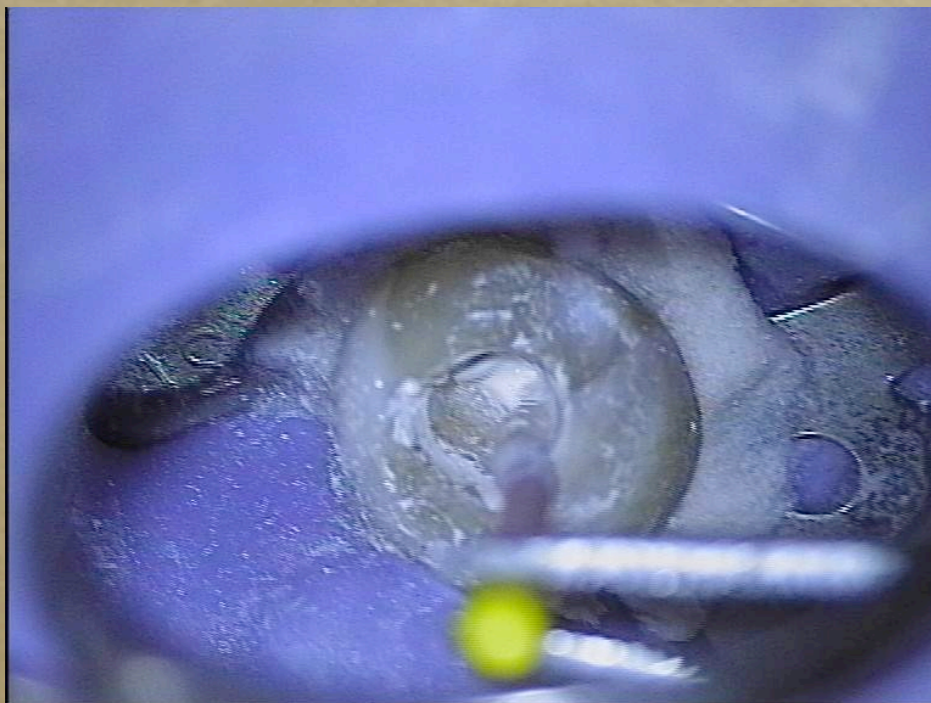
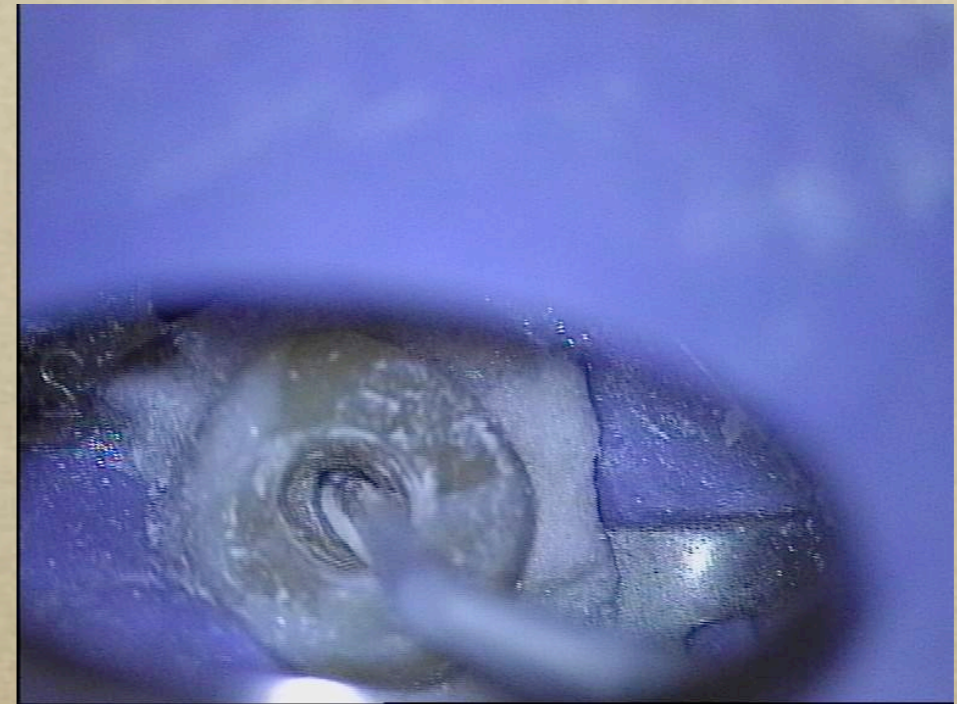
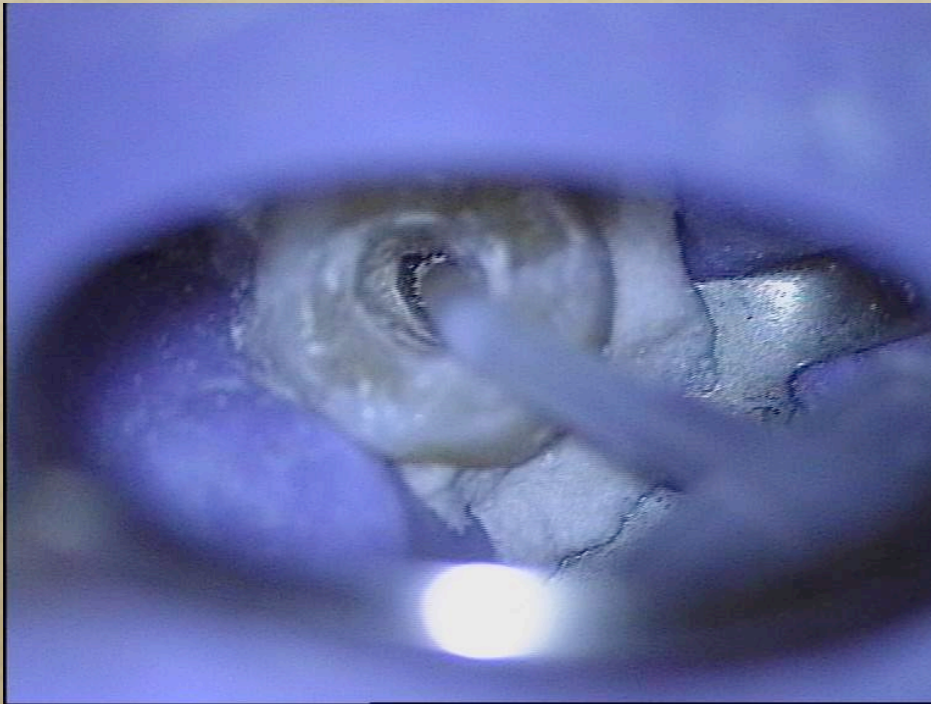
TotalFill BC
IRRIGATION NaOCl
CONE FIT



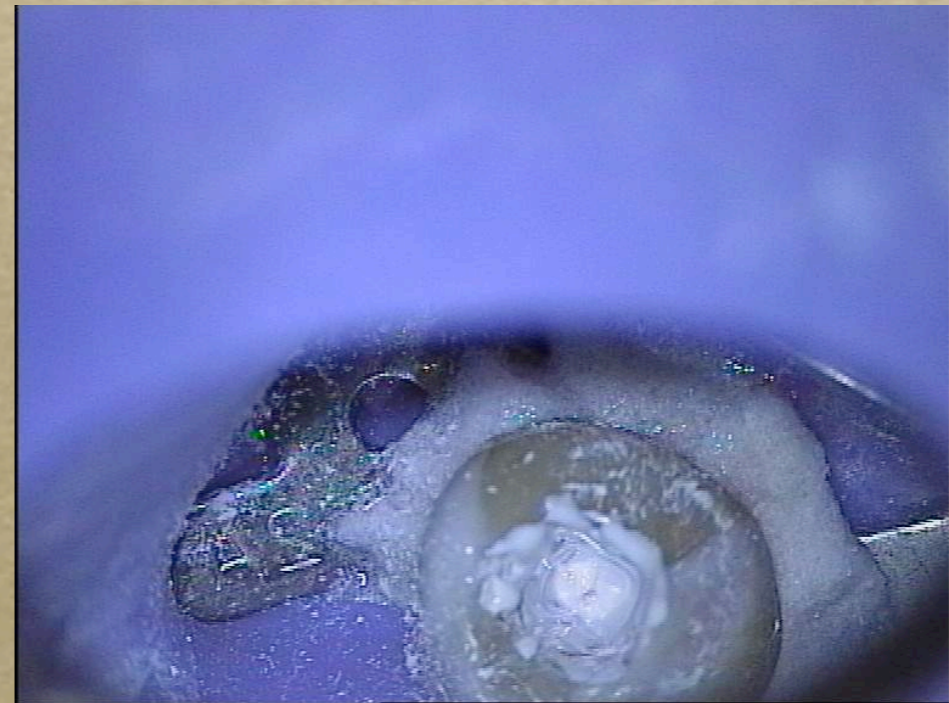
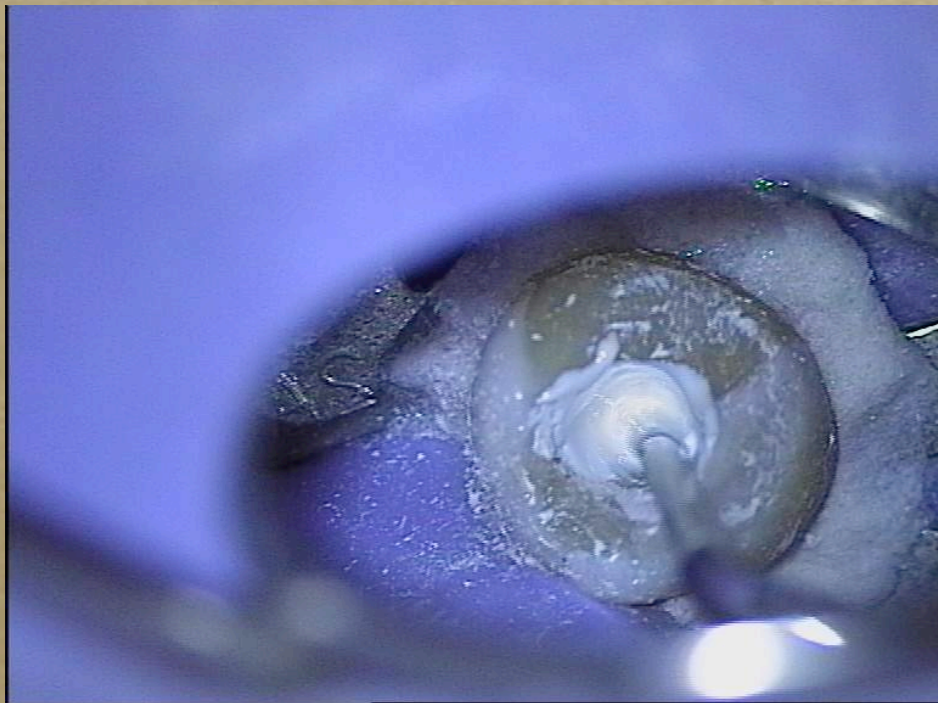
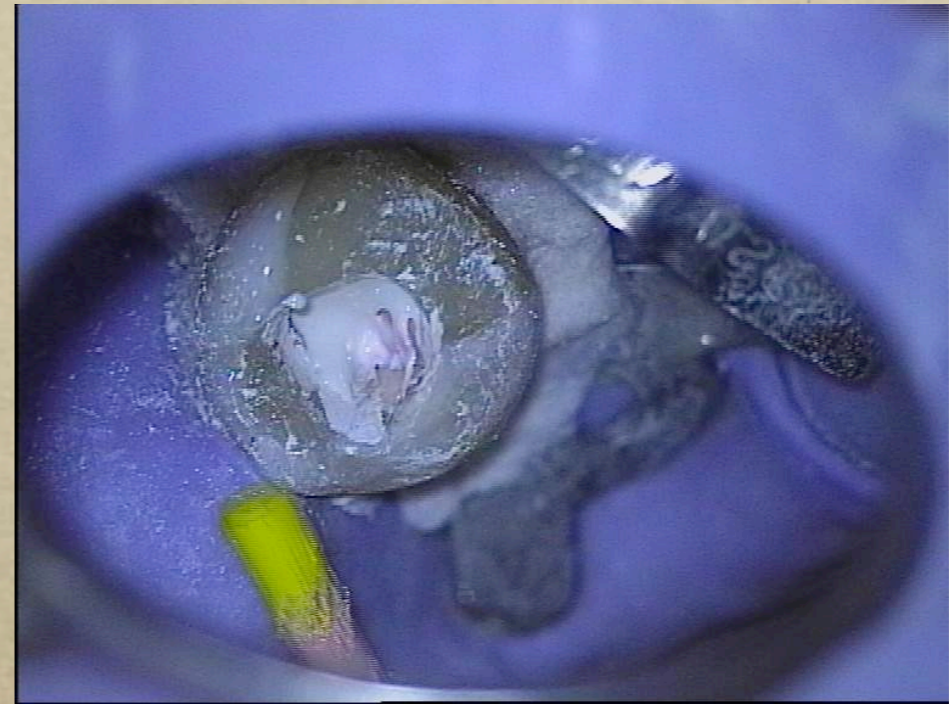
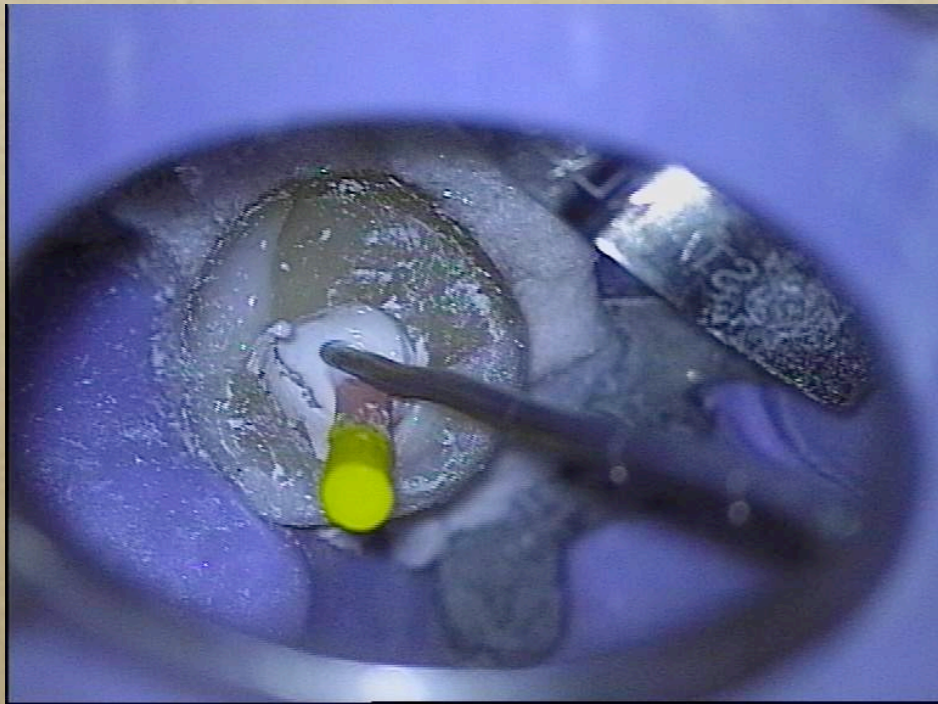
TotalFill BC
IRRIGATION saline solution
DRYING



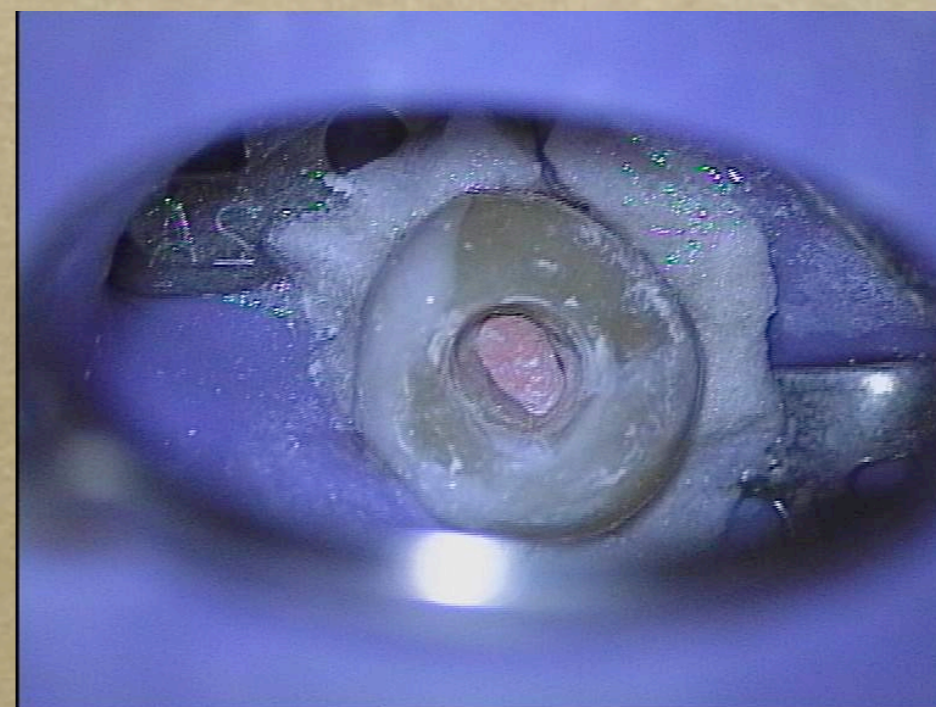
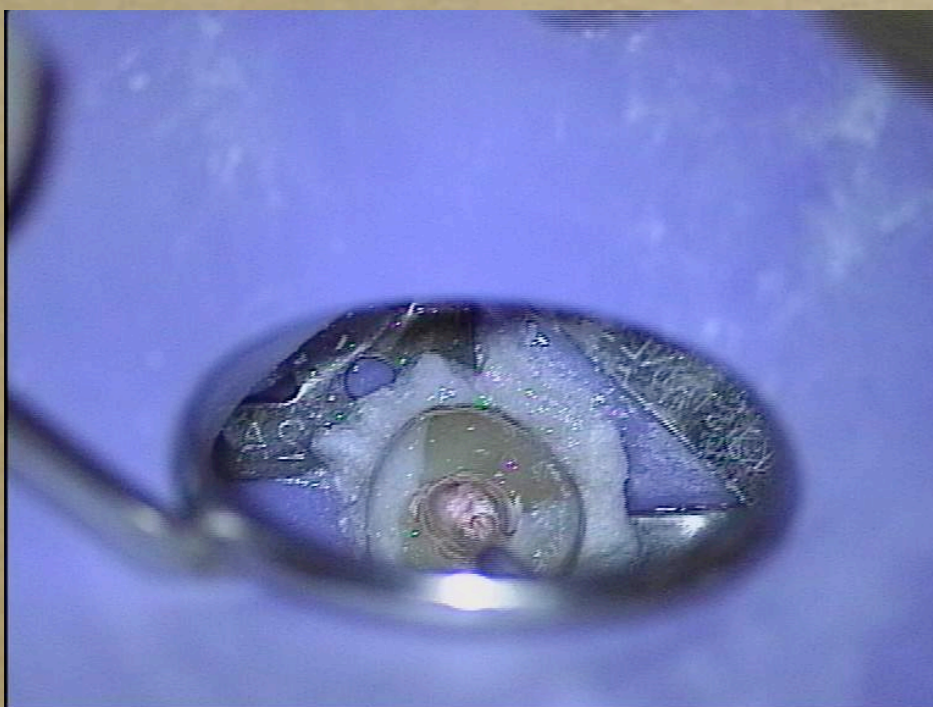
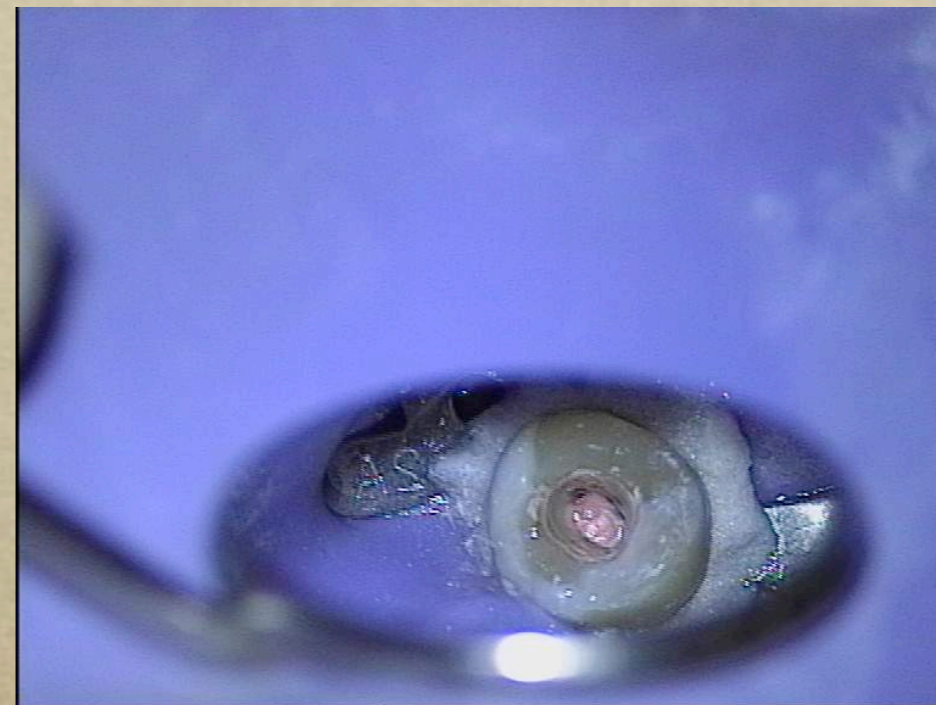
TotalFill BC
APPLICATION TotalFill BC
APPLICATION MASTERCONE TO WL



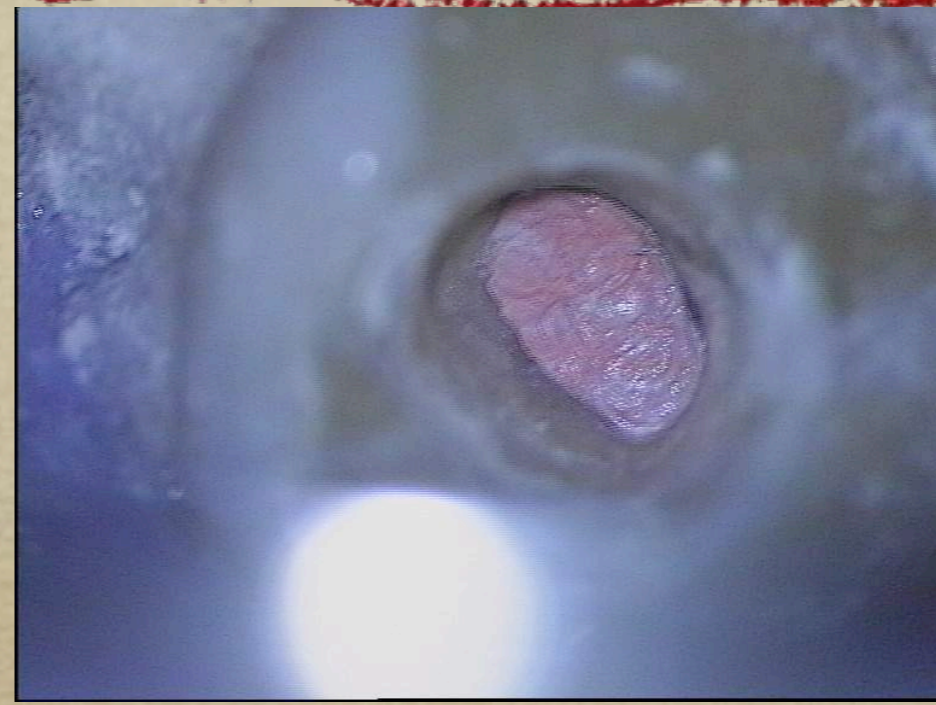
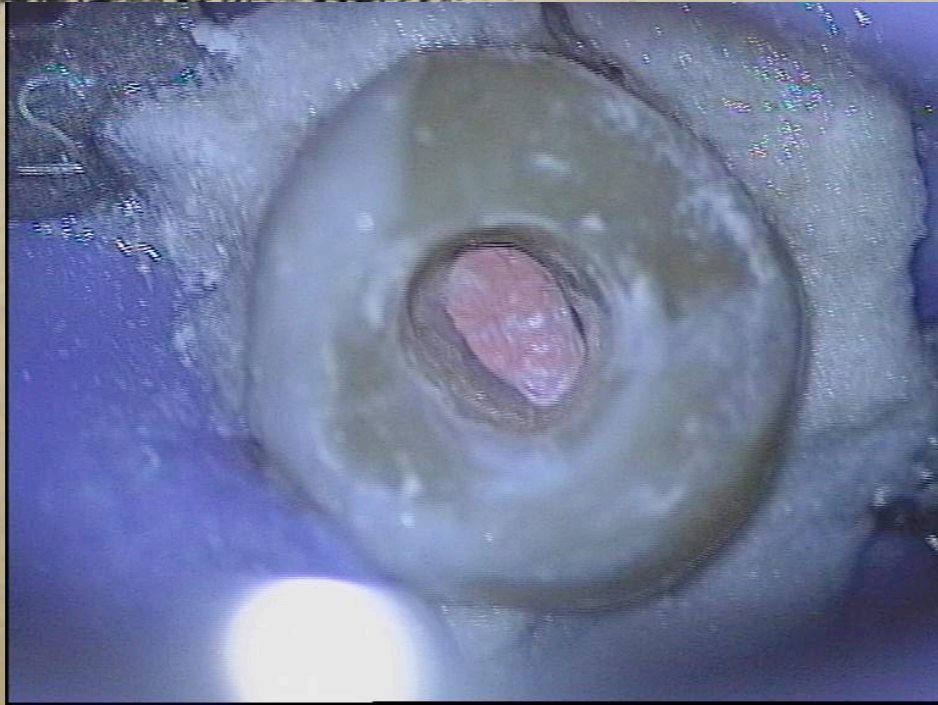
TotalFill BC
DOWN-PACK
COLD PLUGGER CONDENSATION

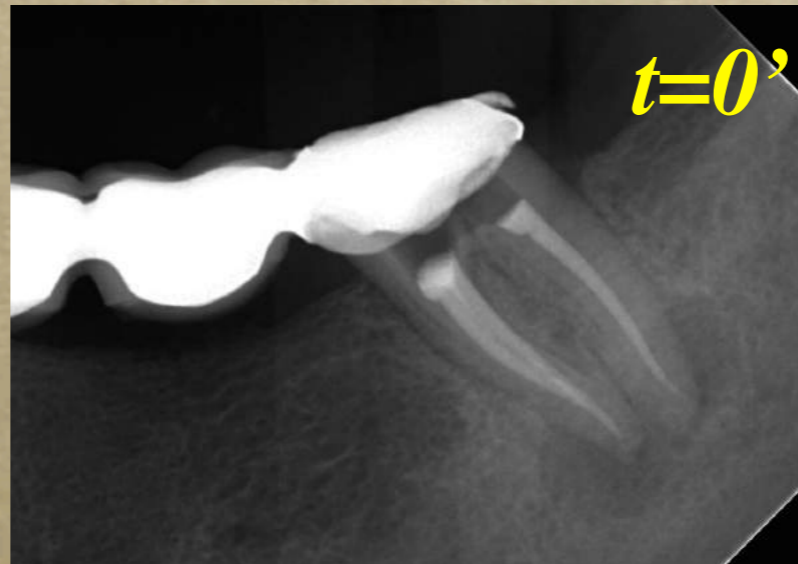
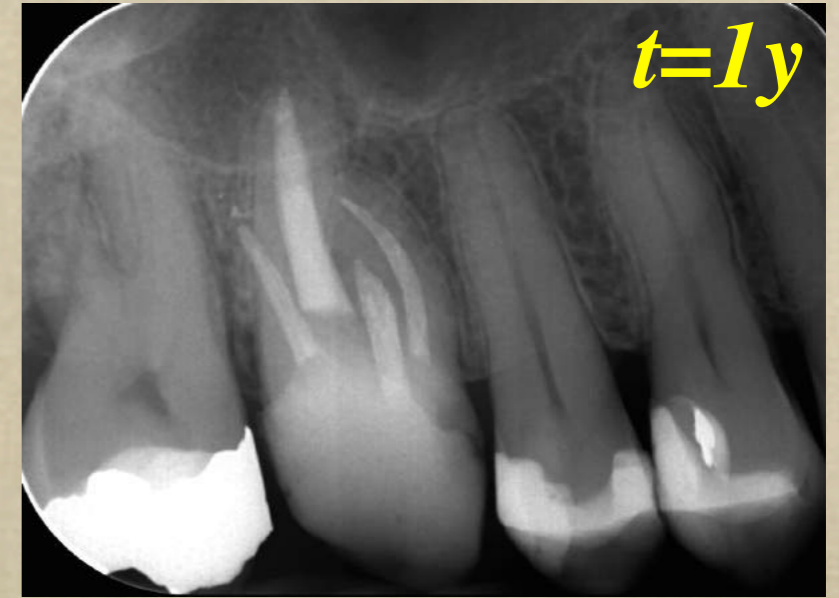
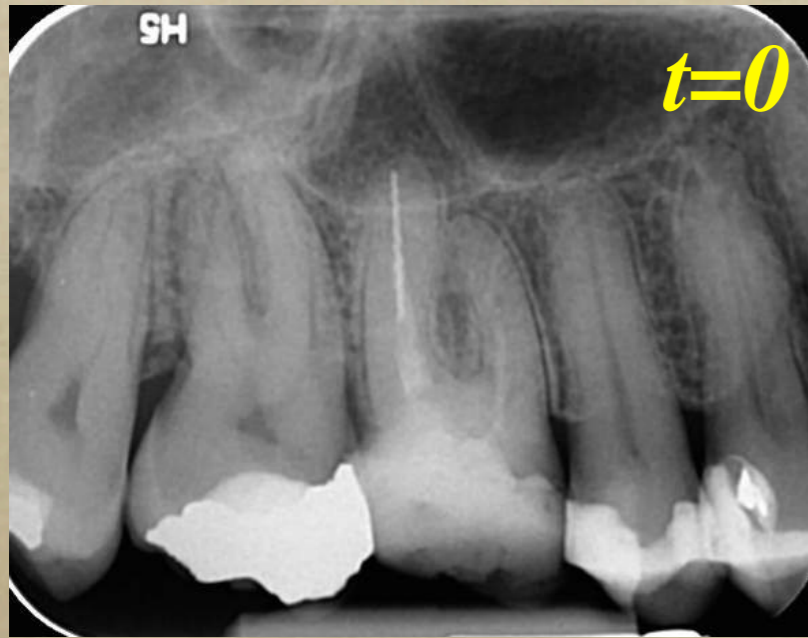


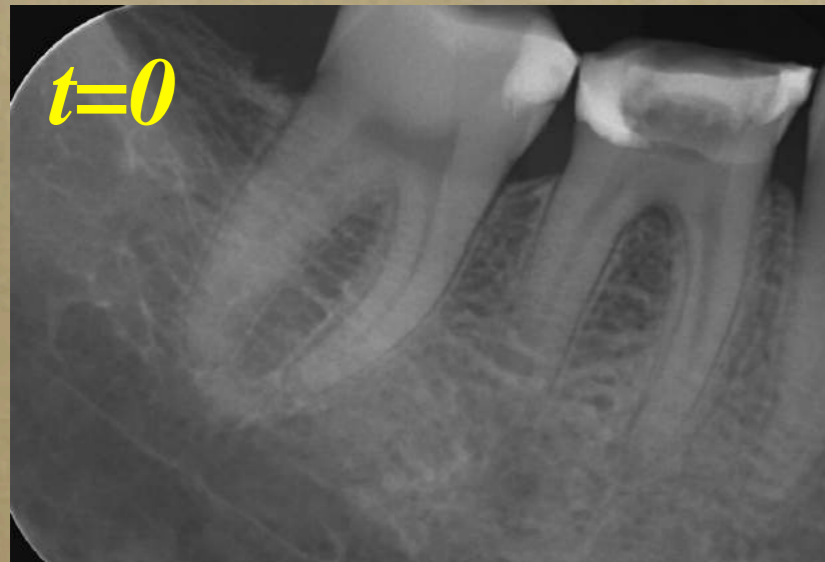
TotalFill BC
*CLEANING ACCESS CAVITY
COLD PLUGGER CONDENSATION*



TotalFill BC
COLD PLUGGER CONDENSATION



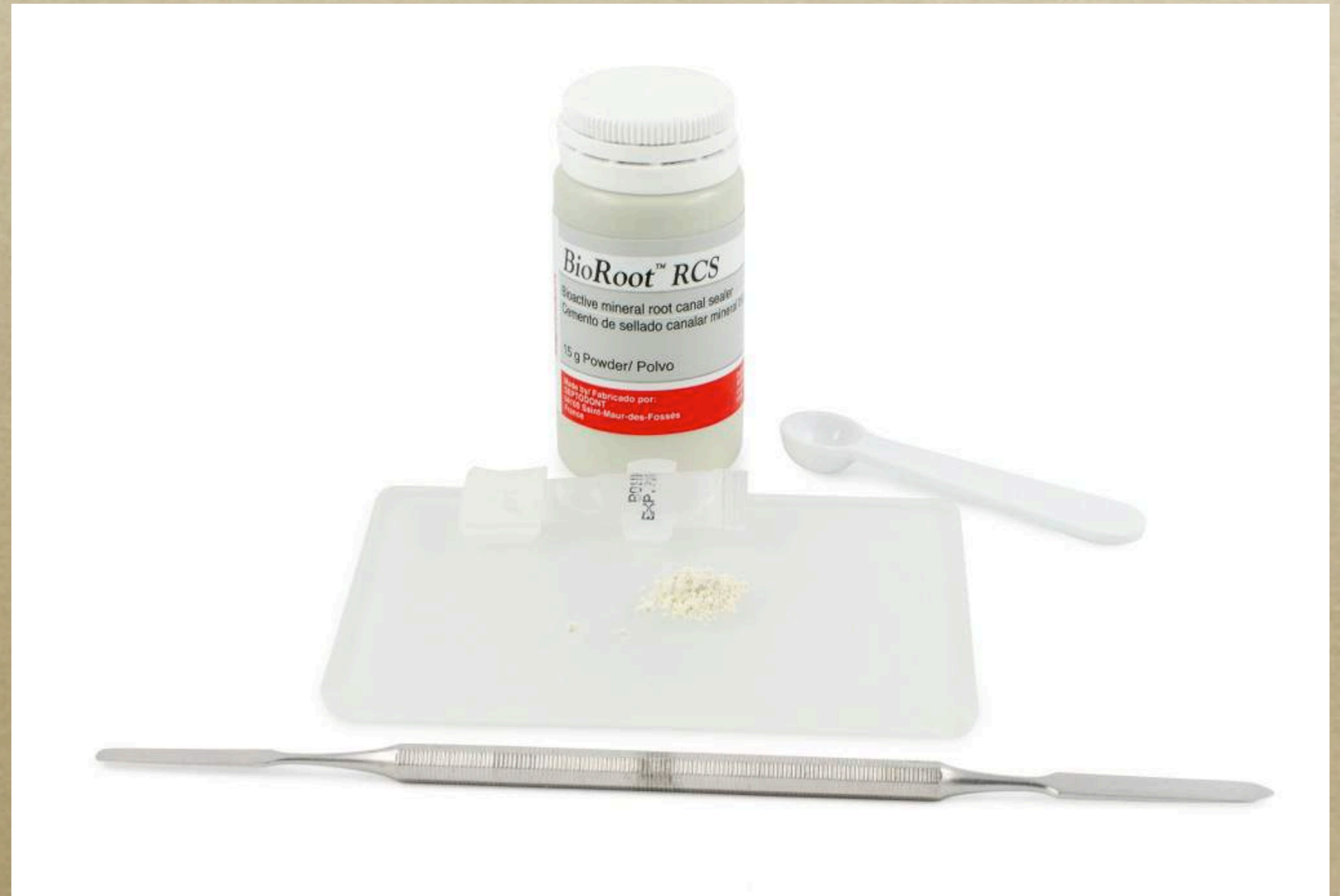




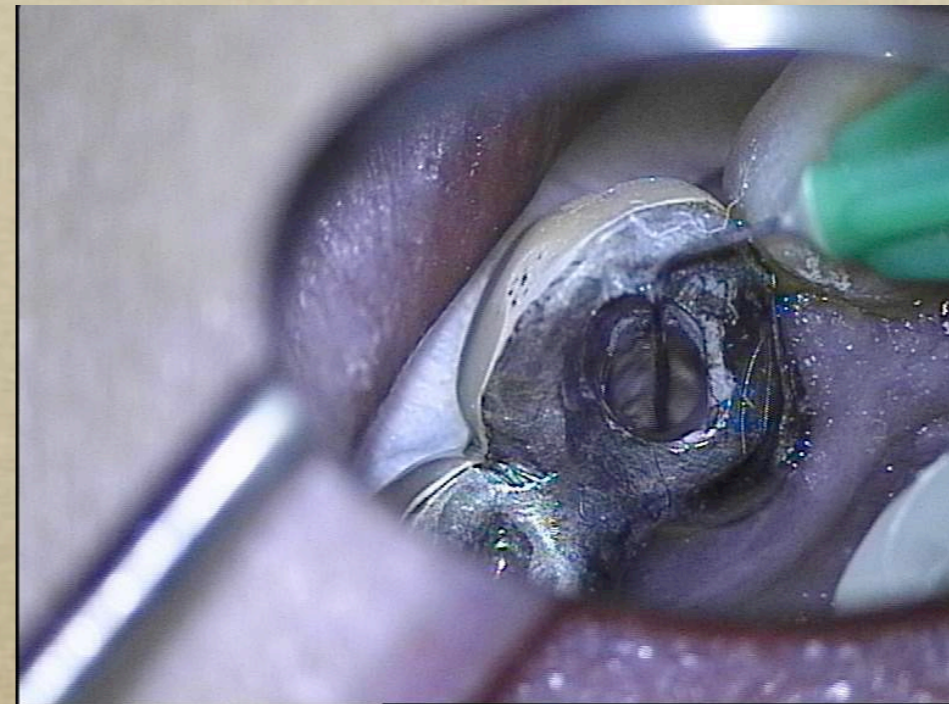
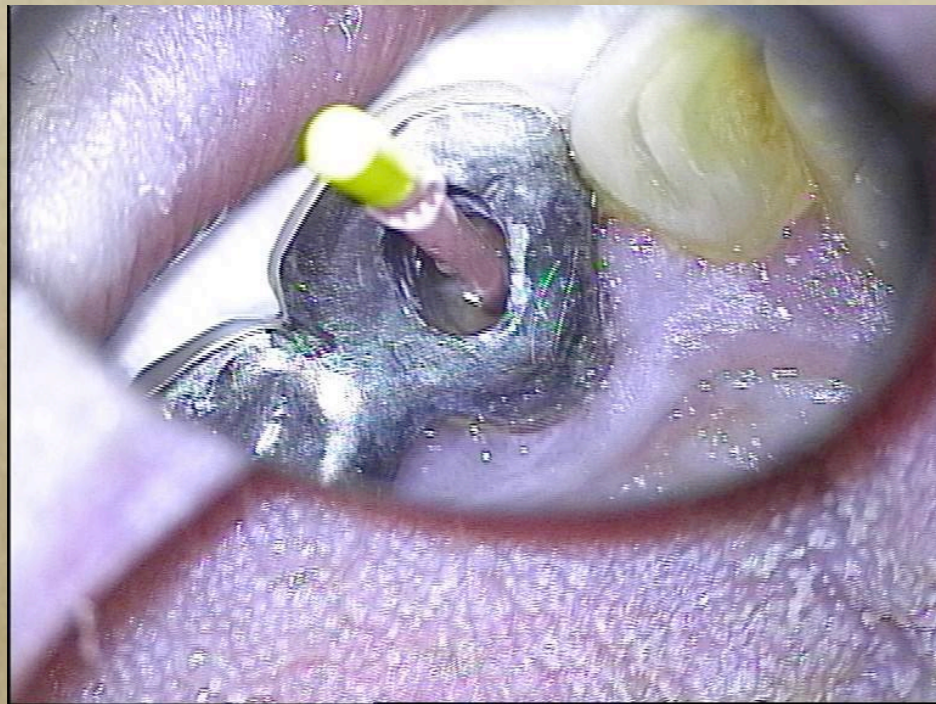
Clinical use of bioceramic sealer

BioRoot RCS SEPTODONT

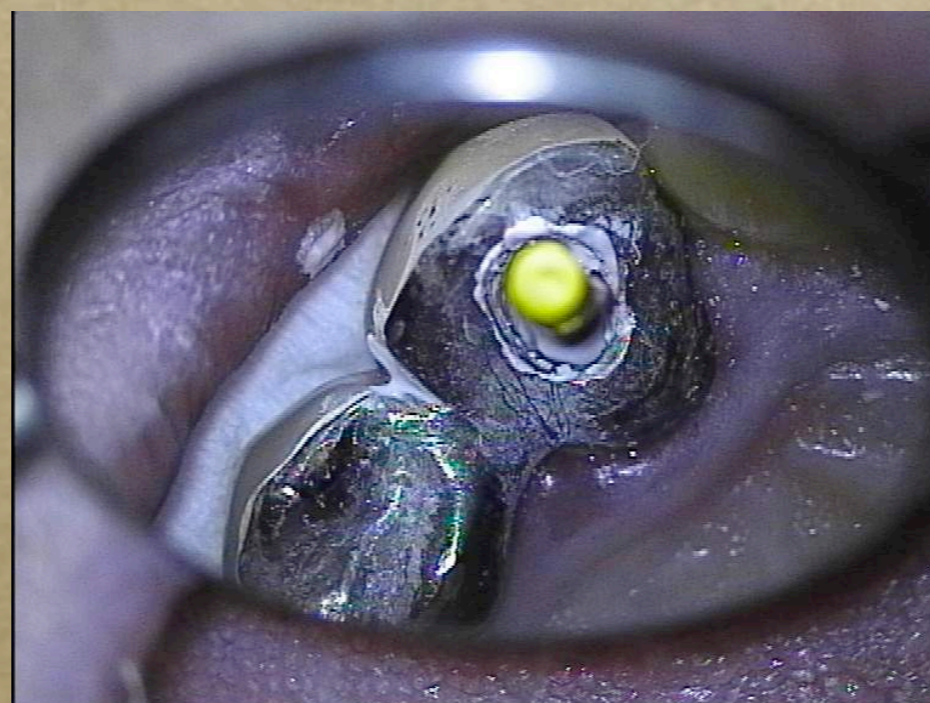
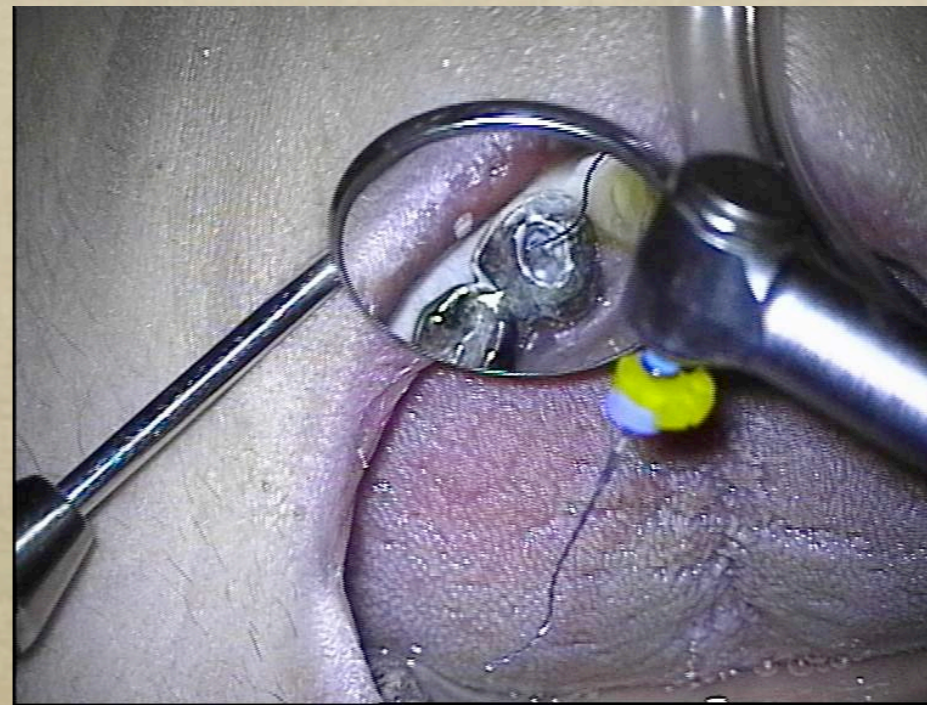
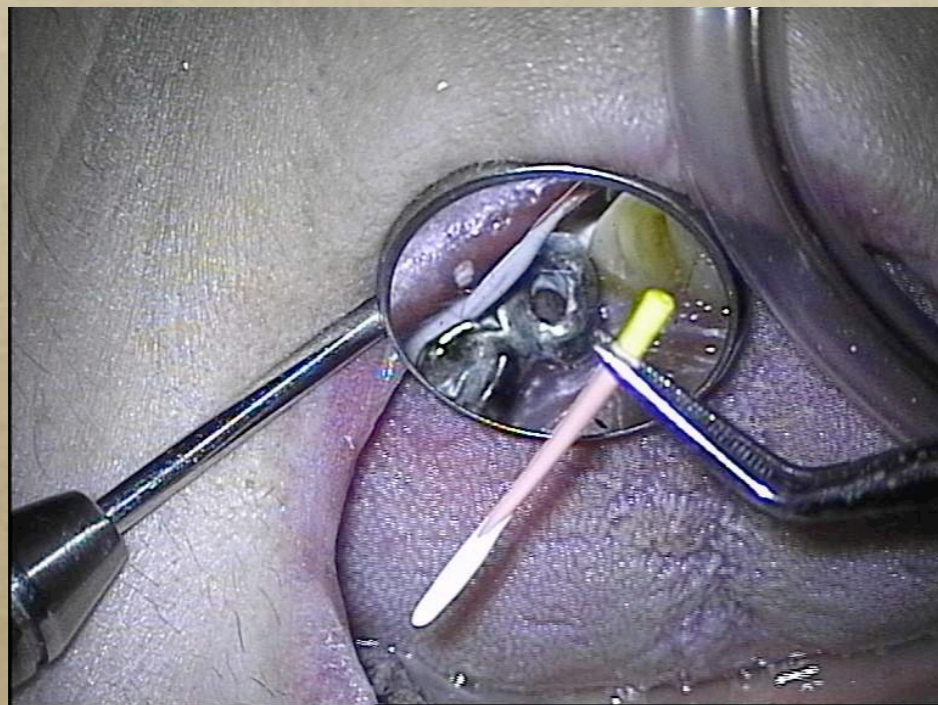
- *powder*
- *liquid*



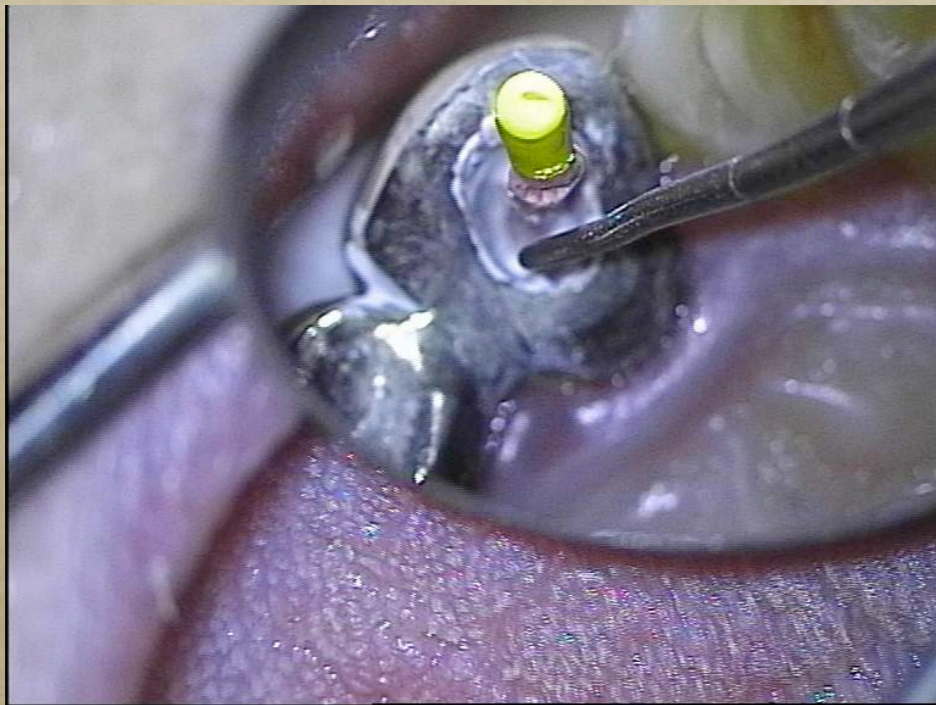
BioRoot RCS
CONE FIT
IRRIGATION saline solution
DRYING



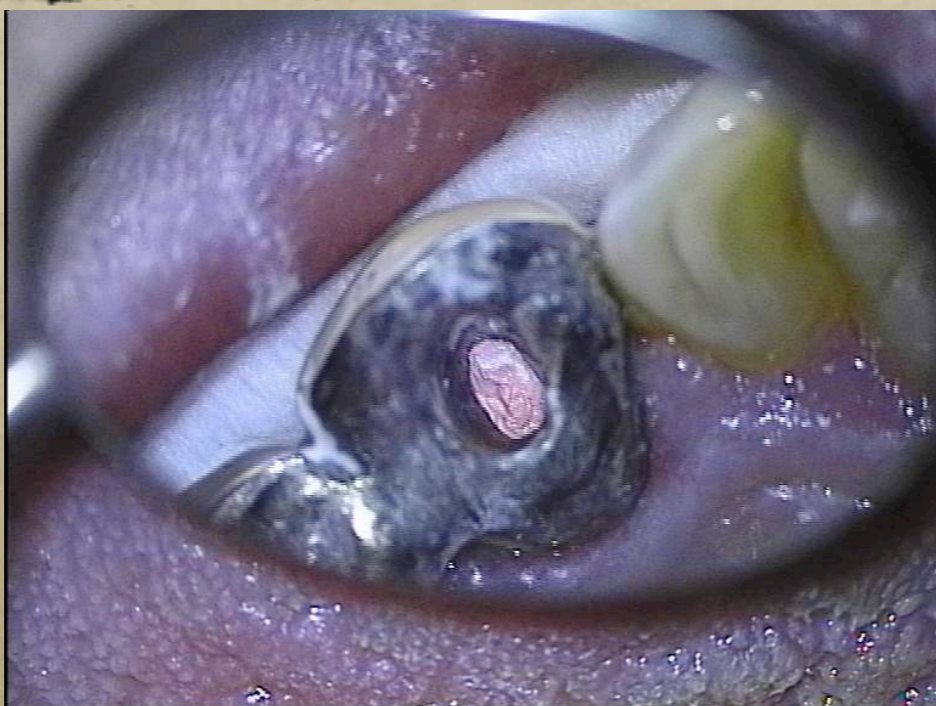
BioRoot RCS
APPLICATION BioRoot
BioRoot PAINTING ON THE WALLS WITH XPF
MASTERCONE APPLICATION

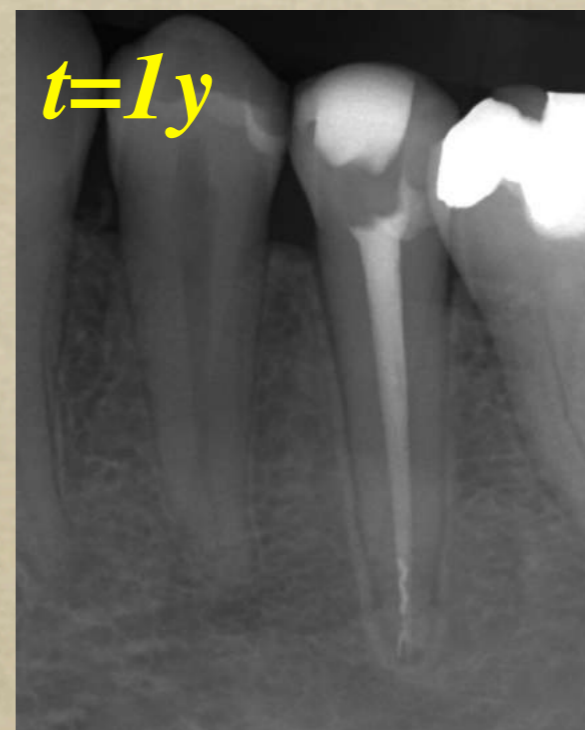


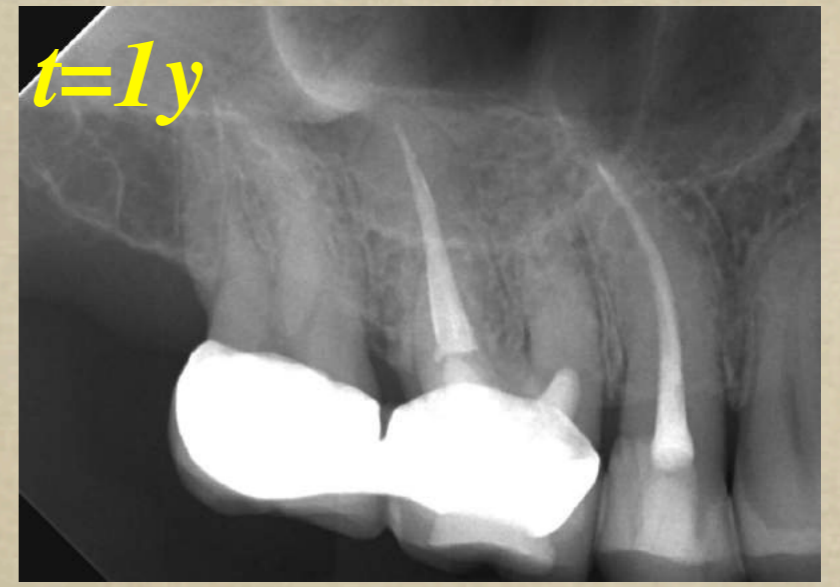
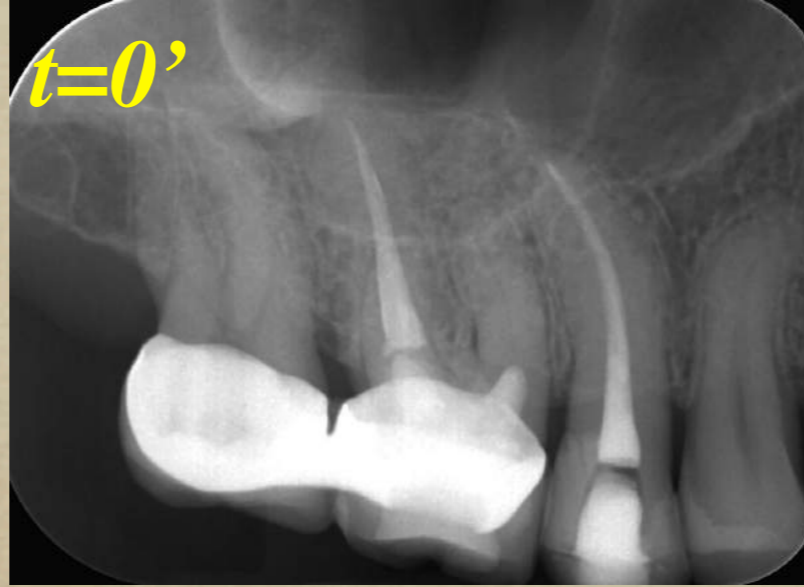
BioRoot RCS
DOWN-PACK
COLD PLUGGER CONDENSATION
CLEANING ACCESS CAVITY



BioRoot RCS
DOWN-PACK
COLD PLUGGER CONDENSATION







CONCLUDING REMARKS

- *bioceramic sealers are changing long-held rules of mechanical preparation, irrigation and obturation of the root canal.*

Trope M, Bunes A, Debelian G. Endod Topics 2015; 32: 86-96.

- *more clinical studies are needed (prospective cohort, RCT, meta-analysis) to show equal or better properties of bioceramic comparing to traditional filling materials.*

Orstavik D. Endod Topics 2014; 31: 53-67.

- *God helps those who help themselves.*

my father Pavel, 1935-1994.

Thank you for your attention

doc. dr. Tomislav Jukić, dr. dent. med.
Zavod za dentalnu medicino
Medicinska fakulteta
Univerza Josipa Jurja Strossmayerja, Osijek

ROK JURIČ
DMD
specialist in endodontics

O|D|O|N|T|O|S
Odontos d.o.o.
Kotnikova 5, 1000 Ljubljana, Slovenia
tel.&fax +386 1 23 23 23 1
rok.juric@odontos.si
www.odontos.si