

- ### Instrument removal
- Incidence of file fracture
  - Success rates of file removal
  - Risks of file removal
  - Removal techniques
  - Decision making when to leave or remove a file

- ### Incidence of instrument fracture/ prevalence of retained fragments
- Between 0.25-24%, based on different denominators *Cheung 2009*
  - Some results based on total numbers of instruments used or discarded from a clinic
  - Others based on the amount retained in root canal treated teeth
  - Estimated prevalence of retained fragments in rct teeth: 1.6% (mostly SS)
  - For NiTi rotaries: 1% of all treated canals *Parashos and Messer 2006*

Paper	Number	Success: removal & bypassing	Success: removal	microscope
Hülsmann & Schinkel 1999	113 fragments, in vivo	68%		no
Shen et al. 2004	72 cases, in vivo	53%		no
Suter 2005	97 fragments, in vivo		87%	yes
Souter & Messer 2005	60 cases		70%	yes
Tzanetakis et al. 2008	94 fragments	48% (residents)		yes
Alomairy 2009	30 teeth, in vitro		70%	no
Cujé et al. 2010	170 fragments		95%	yes
Nevares et al. 2012	112 fragments in vivo 58 visible fragments	70.5% 85.3%		yes

### Factors influencing the success or failure of removing fractured instruments

- Canal configuration (straight vs curved canals)
- Localization of fragment in relation to curvature
- Degree of curvature
- Length of fragment
- Type of fragment
- Use of microscope
- Clinical skills

*Hülsman et al. 1999, Shen et al. 2004, Suter 2005, Souter & Messer 2005, Alomairy 2008, Tzanetakis et al. 2008, Cujé et al. 2010*

### Non-surgical removal techniques

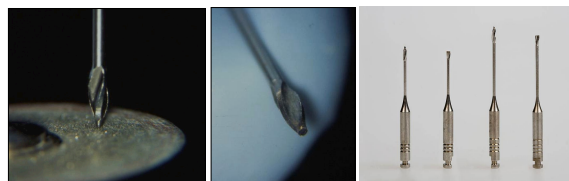
- Use high magnification and maximum lighting level
- Staging platform and ultrasonics
- Braiding technique
- Instrument Removal System (IRS)
- Tube and composite

### Non-surgical removal techniques

- Use high magnification and maximum lighting level
- Staging platform and ultrasonics



### Modify a Gates Glidden Drill



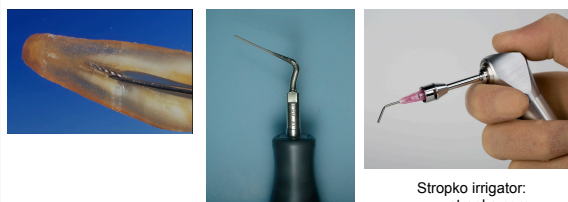
Courtesy of Dr. Gary Carr

### Create a staging platform



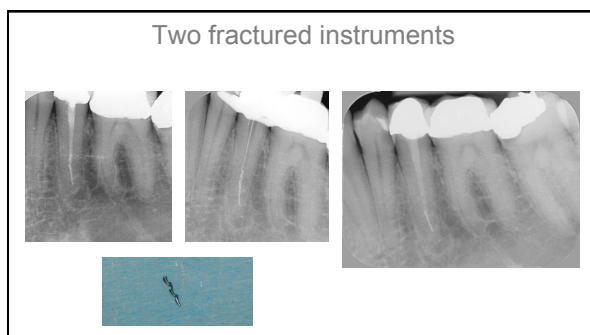
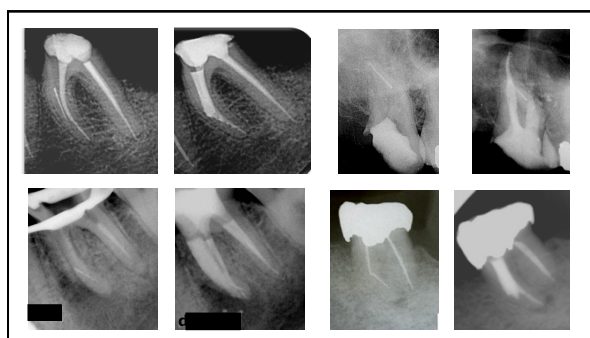
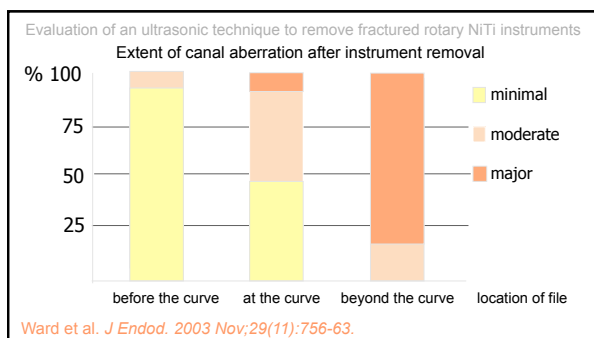
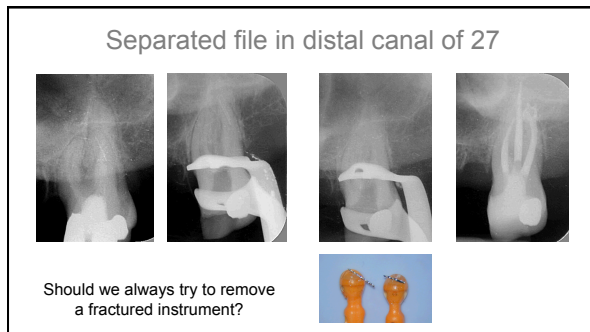
Courtesy of Dr. Gary Carr

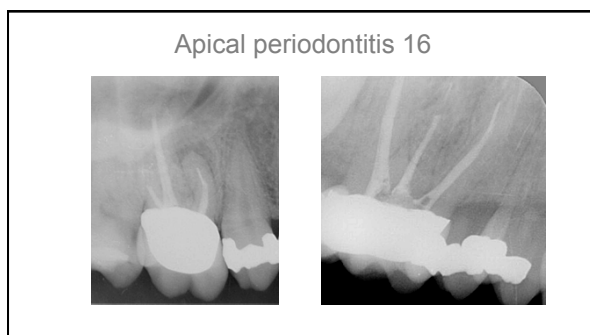
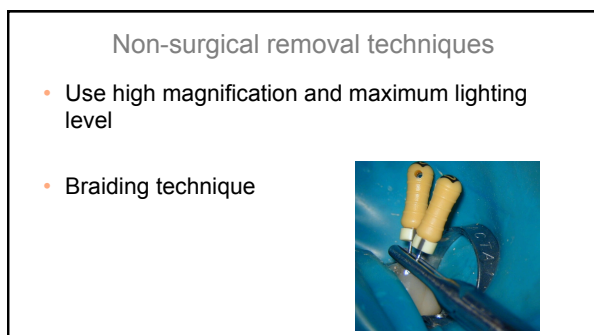
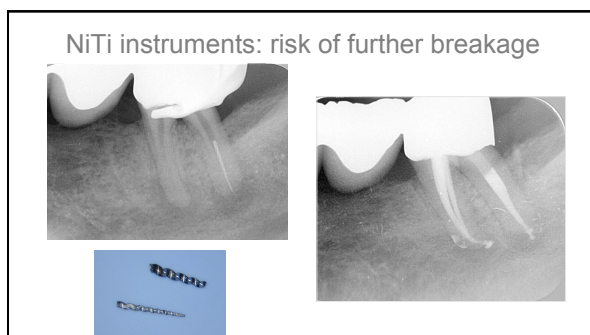
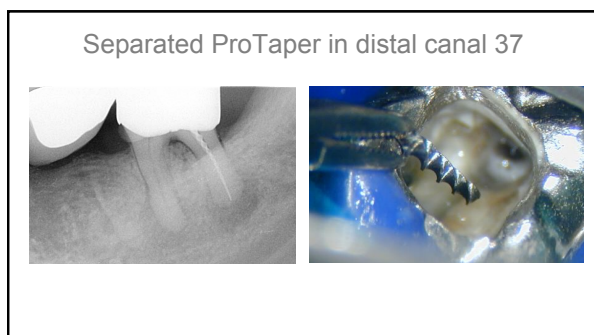
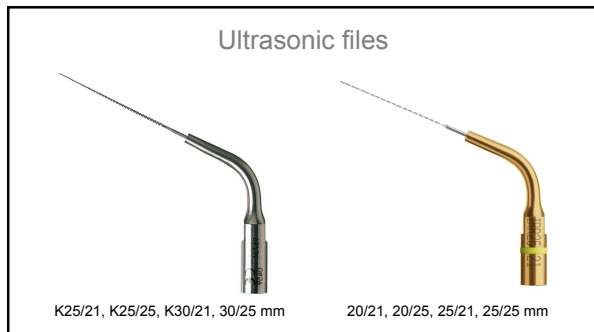
### Make a trough with an ultrasonic tip

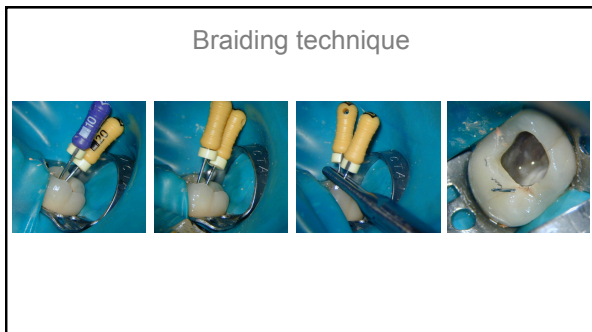


Stropko irrigator:  
www.stropko.com





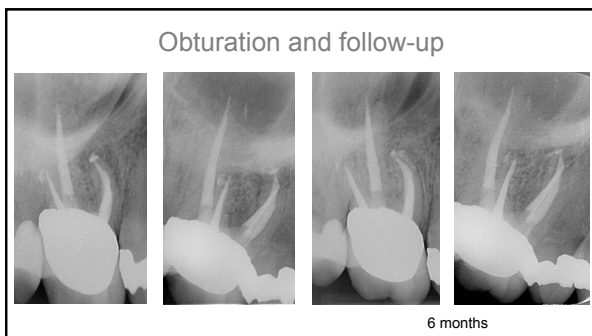




**REF A 012X**

	(x)	(x)	(x)
<b>008</b>	Δx 04	Δx 04	Δx 04
<b>010</b>	Δx 12	Δx 10	Δx 10
<b>015</b>	Δx 15	Δx 15	Δx 15
	18 mm	21 mm	25 mm

C+ files: pyramid-shaped tip and unique taper for stiffness, up to a 142% gain in buckling force over standard K-Files



### Non-surgical removal techniques

- Use high magnification and maximum lighting level
- Instrument Removal System

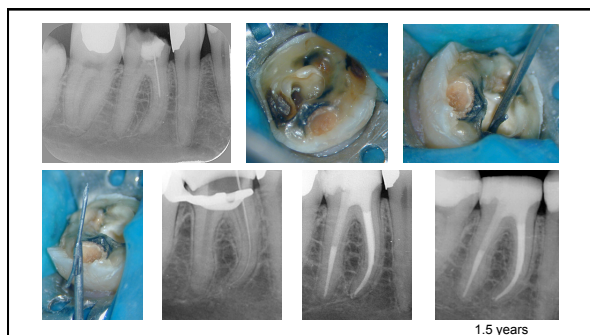
### Instrument Removal System

**IRS The Mechanical Advantage**

The new Instrument Removal System (IRS) is a revolutionary instrument designed for non-surgical removal of instruments.


- Engage with Ultrasonics
- Position the file stable
- Engage and Remove

**Disport**  
SUDON



Non-surgical removal techniques

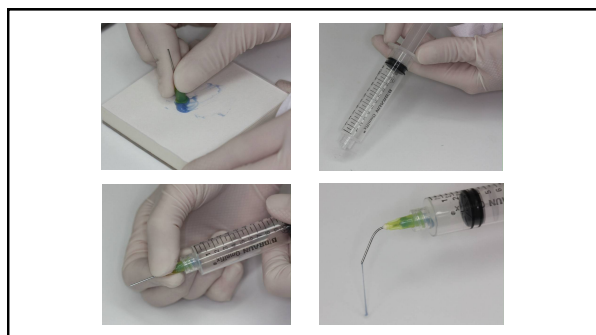
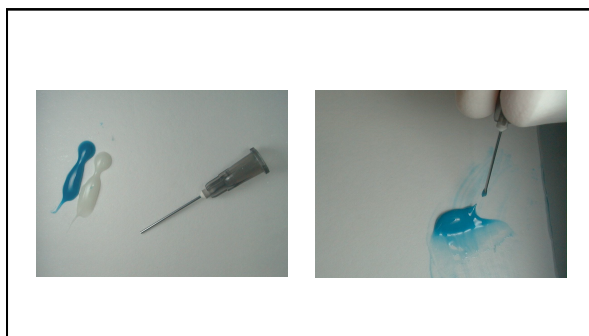
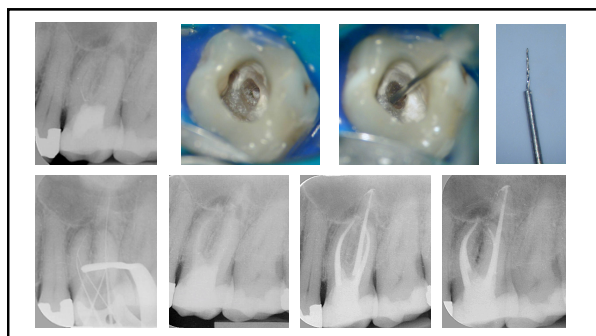
- Use high magnification and maximum lighting level
- Tube and composite



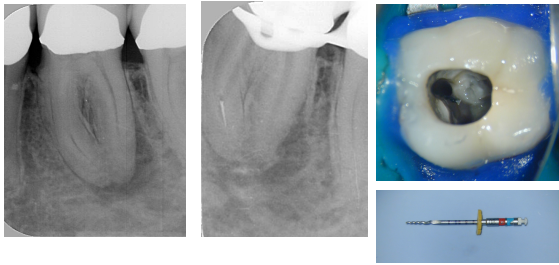
Vista bendable needle tips: [www.vista-dental.com](http://www.vista-dental.com)

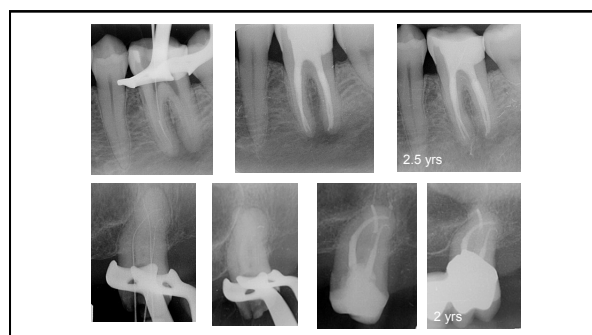
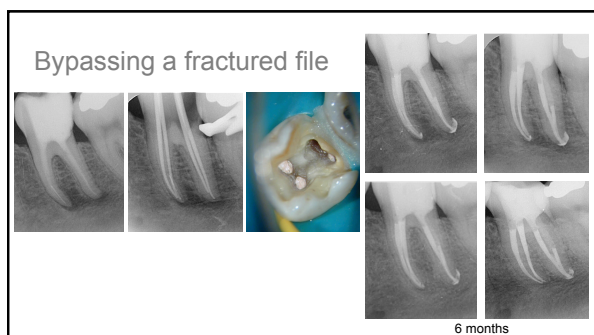
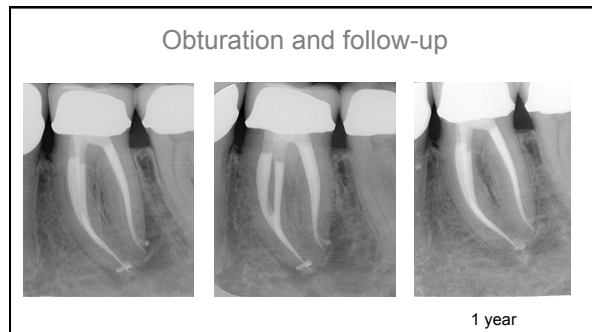
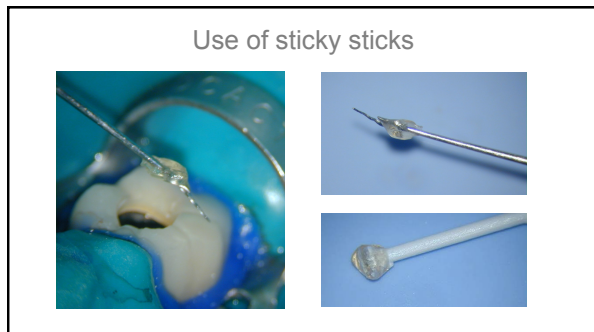


Available in: 16 gauge=1.65 mm      20 gauge=0.90 mm  
18 gauge=1.25 mm      22 gauge=0.70 mm  
19 gauge=1.06 mm      30 gauge=0.30 mm



Separated TF





### The impact of instrument fracture on outcome

- The frequency of instrument fracture and its impact on treatment outcome were determined from an analysis of specialist endodontic practice records involving 8460 cases (1990-2003)
- Overall frequency of fractured instruments was 3.3%
- Overall healing rates 91.8 % for cases with a fractured instrument, 94.5% for matched controls
- Healing in both groups was lower in teeth with a prep. lesion: 86.7% for cases with a fractured instrument vs 92.9% for matched controls

*Spili et al. J Endod. 2005 Dec;31(12):845-50.*



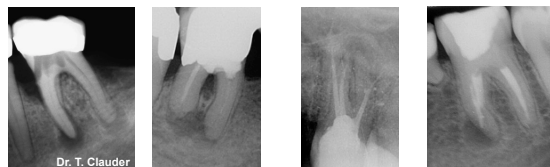


### Factors influencing the decision to remove or leave a fractured instrument

- Pulp status
  - Vital /Necrotic
- Stage of preparation
  - Initial/Final
- Canal configuration
  - Straight/Curved
- Location of fractured instrument
  - Before, at or beyond the curve
- Type of instrument
  - NiTi /SS
  - Cross-section and geometry

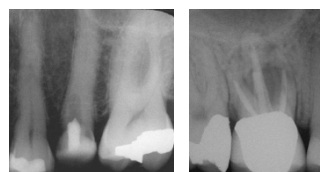
### Perforations

- Etiology
- Diagnosis
- Treatment
  - Materials for repair
  - Armamentarium
- Treatment outcome



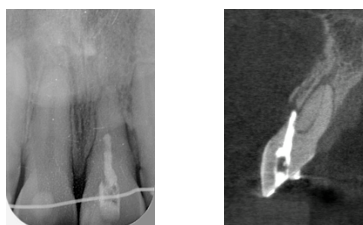
- Injury to periodontium
    - Inflammation
    - Destruction of periodontal fibers
    - Bone resorption
    - Apical migration of epithelial attachment
- } Periodontal defect

### Diagnosis of an existing perforation



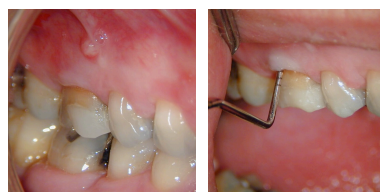
- Based on radiographic assessment
- Pre-operative radiographs
  - CBCT
  - Location of the radiolucency

### Diagnosis of an existing perforation



Cone Beam Computed Tomography

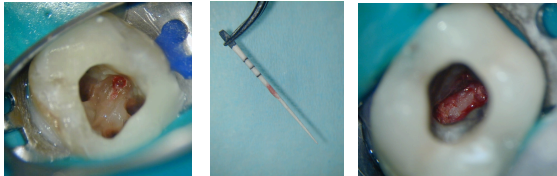
### Diagnosis of an existing perforation



- Based on clinical examination
- Pockets
  - Furcation involvement
  - Sinus tracts




### Identification during treatment



- Direct observation through the microscope
- Indirect assessment with paper points
- Pain and bleeding at an unusual location

### Identification during treatment

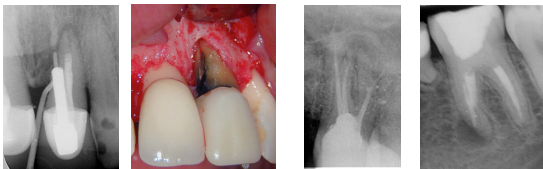


- Apex locator
- Radiograph
- CBCT

### Management of perforations

- Decision to treat or not
- Non-surgical, surgical or combination
- Selection of repair material
- Restorative follow-up treatment

### Factors in determining the success of perforation repair




- Location
- Time

*Pitt Ford et al. 1995, Fuss & Trope 1996, Arens et al. 1996, Holland et al. 2007*

### Materials for perforation repair

- Amalgam
- Calcium hydroxide
- Super-EBA
- Glass ionomer
- Composite
- Gutta-percha
- Zinc-oxide eugenol cement
- MTA
- Bioceramic materials

### Supracrestal perforations



Don't use MTA



- Gray and white MTA are similar to Portland cement, with bismuth oxide added for radiopacity
- Portland cement itself is a mixture of:
  - Dicalcium silicate
  - Tricalcium silicate
  - Tricalcium aluminate
  - Calcium sulphate
  - Tetracalcium aluminoferrite

*Camilleri et al. '05, Sarkar et al. '05, Dammaschke et al. '05, Roberts et al. '08*

### Bioactivity of MTA

- When MTA comes in contact with water, it releases  $\text{Ca(OH)}_2$  (pH 11-12)
- $\text{Ca(OH)}_2$  can interact with phosphates in tissue fluids to form hydroxyapatite
- This may explain some of the tissue-inductive properties of MTA

*Fridland & Rosado 2003, Camilleri et al. 2005, Sarkar et al. 2005, Bozeman et al. 2006, Tay et al. 2007, Coleman et al. 2008*

### 16-year old girl presents with big swelling

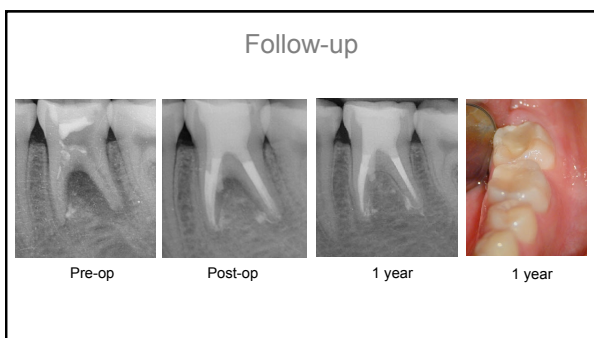
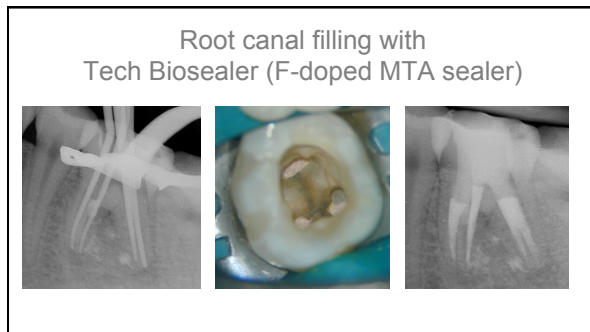
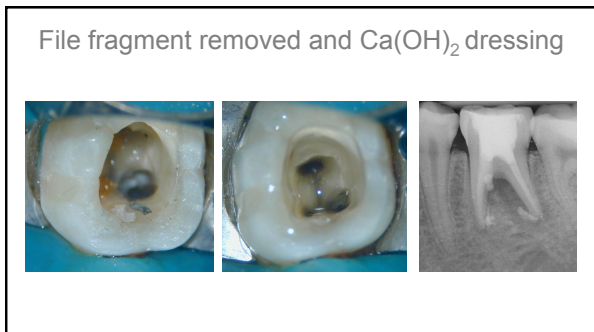
The image contains two radiographs. The left radiograph shows a tooth with a large swelling. The right radiograph shows a tooth with a large swelling and a root canal filling.

### Bypassing fractured instrument and application of MTA

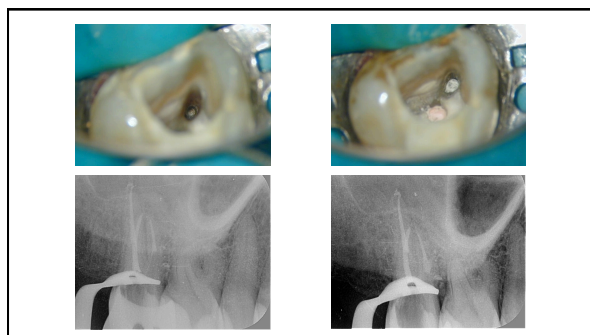
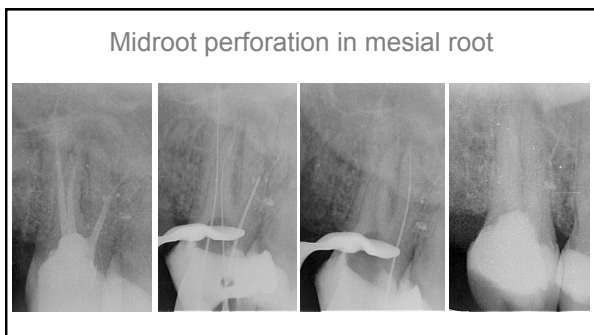
The image contains three panels. The left panel shows a clinical view of a tooth with a fractured instrument. The middle panel shows a radiograph of a tooth with a fractured instrument. The right panel shows a radiograph of a tooth with a fractured instrument and MTA application.

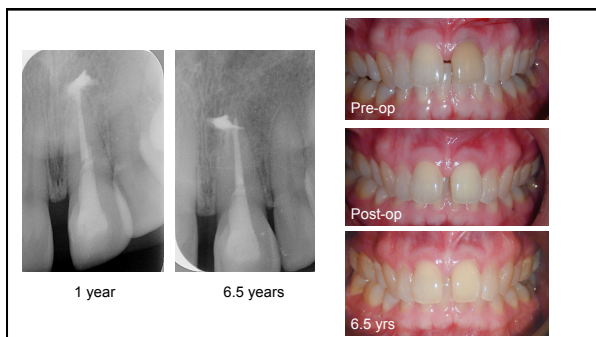
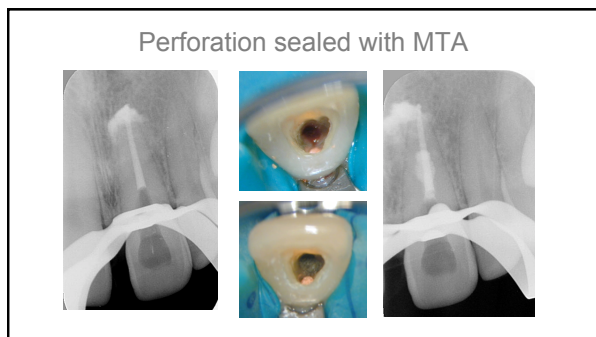
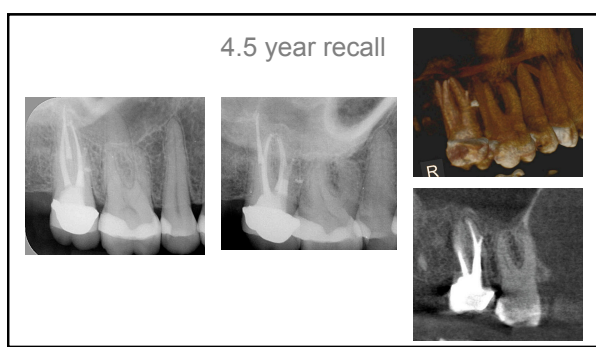
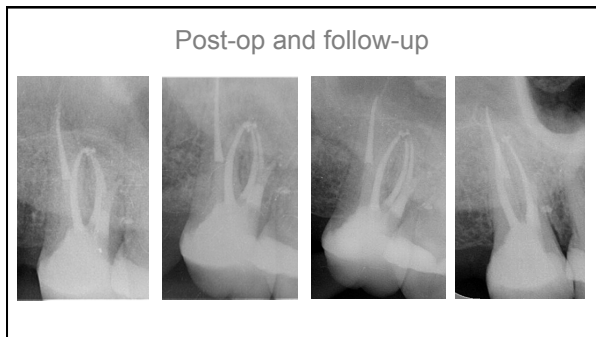
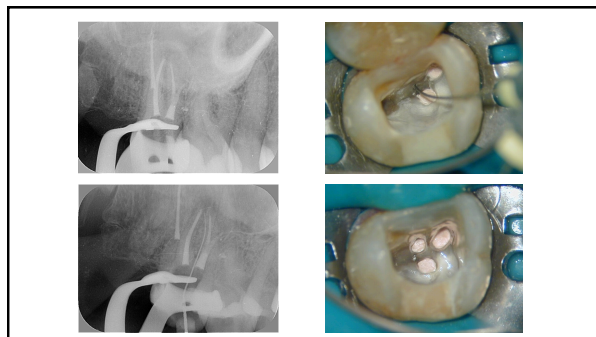
### MTA carriers

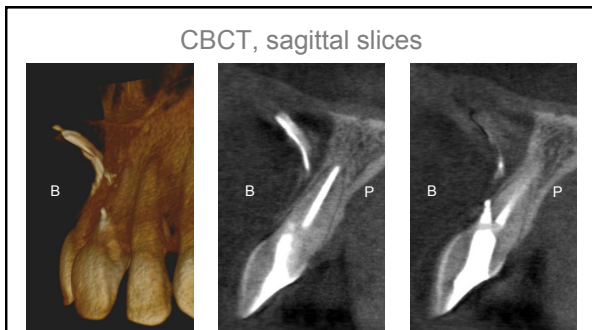
The image shows three types of MTA carriers: Dovgan carriers (Hartzell and Son), Disposable Dovgan carriers, and the MAP system (Maillefer).



- When to restore?
- Recommendations for placing final restoration vary from 1 day to 1 week
  - Resistance to dislodgement improves significantly at a time range of 72 h
  - Acid-etch procedures affect the compressive strength and surface microhardness of ProRoot MTA. It may be better to postpone restorative procedures for at least 96 h after mixing MTA
- Arens et al. 1996, Pitt Ford et al. 1995, Sluyk et al. 1998, Kavahan et al. 2009







**Long-term treatment outcome**

- 16 perforation cases (5 lateral, 5 strip, 3 furcal and 3 apical perf) repaired with MTA demonstrated normal tissue architecture adjacent to the repair site at the recall visit after 1 year  
*Main et al. J Endod. 2004 Feb;30(2):80-3*
- 9 out of 10 furcal perforation cases sealed with MTA showed a successful outcome after 5 years (one patient dropped out of the study)  
*Pace et al. J Endod. 2008 Sep;34(9):1130-3*
- 18 out of 21 perforation cases (various locations) sealed with MTA showed complete healing at the follow-up after 1-5 years (mean 3 years)  
*Mente et al. J Endod. 2010 Feb;36(2):208-213.*

**Case Report/Clinical Techniques**

**Management of Perforations: Four Cases from Two Private Practices with Medium- to Long-term Recalls**

*Margie Riv, DDS, MSc,\* and Richard Schwartz, DDS<sup>†</sup>*

**Abstract**  
Introduction: Perforation repair is a fairly common endodontic procedure, but most of the final steps in the endodontic procedure are short-term (ie, 1-2 years). The purpose of this article was to report 4 clinical cases of perforation repair with medium- to long-term recall. Methods: Four cases were selected with different clinical scenarios. The perforation cases were repaired, sealed with root canal sealer, aggregate, and restored. The health care was 100% successful. Results: The patients were followed up to 12 years and presented healthy teeth with no clinical or radiographic evidence of perforation repair. Conclusions: If a perforation repair is done well, it may not be a long-term clinical concern. (J Endod 2012;38:1422-1427)

**Key Words**  
Case report, lateral incisor, aggregate, perforation repair, restoration, surgery

**Introduction**  
Perforation repair is a fairly common endodontic procedure, but most of the final steps in the endodontic procedure are short-term (ie, 1-2 years). The purpose of this article was to report 4 clinical cases of perforation repair with medium- to long-term recall. Methods: Four cases were selected with different clinical scenarios. The perforation cases were repaired, sealed with root canal sealer, aggregate, and restored. The health care was 100% successful. Results: The patients were followed up to 12 years and presented healthy teeth with no clinical or radiographic evidence of perforation repair. Conclusions: If a perforation repair is done well, it may not be a long-term clinical concern. (J Endod 2012;38:1422-1427)

**Case Report**  
Patient #1 was a 12-year-old white female who was referred to 2007 for the endodontic treatment of tooth #11. Her medical history was unremarkable. A clinical examination revealed the tooth #11 to contain an 88% deep carious restoration, and there was a crown fracture under present restorations with #11 with no perforation present. The tooth was carious to present and perforated, and there was an apical perforation depth. A radiographic examination revealed perforation restorations associated with the crown restorations #11. In addition, the radiographic case appeared to be transported and perforated (Fig 1A). The radiographic diagnosis was perforation associated with crown restorations #11. The clinical diagnosis was perforation associated with crown restorations #11. The following treatment was recommended:  
1. To remove the coronal restorations of the tooth when it becomes symptomatic.  
2. Root canal treatment.  
3. Root canal irrigation.  
4. Root canal filling with composite resin.  
5. Surgical treatment to repair the perforation and restore the root end.

**MTA**

- Advantages:**
  - Biocompatible
  - Effective seal against dentin and cementum
  - Promotes biologic repair and regeneration of PDL
  - Non-shrinking
  - Sterile
  - Radiopaque
  - Non-sensitive to moisture and blood contamination
  - Antimicrobial properties
- Disadvantages**
  - Setting time
  - Staining of tooth structure
  - Presence of heavy metals, such as arsenic, chromium, lead
  - Difficult to manipulate
  - Difficult to remove
  - No known solvent
  - Hard to apply in narrow canal configurations

**Bioceramics**

- Inorganic, non-metallic, biocompatible materials that have similar physical characteristics to the tissue that they are replacing or repairing
- Applications:
  - joint replacements
  - coating on heart valves
  - dental implants
  - bone cement etc.

JOURNAL OF biomaterials applications





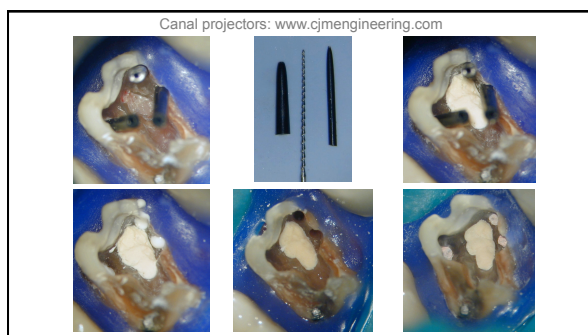
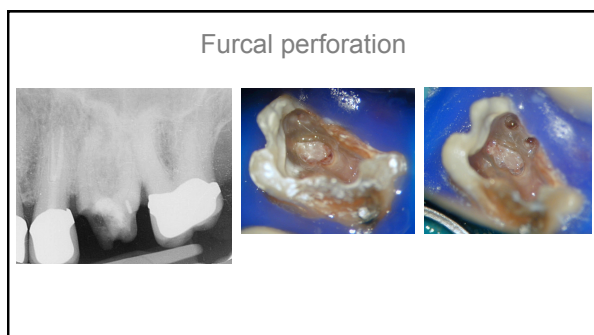
### Endosequence root repair material putty

- calcium silicates
- calcium phosphate
- zirconium oxide
- tantalum oxide
- fillers, thickening agents

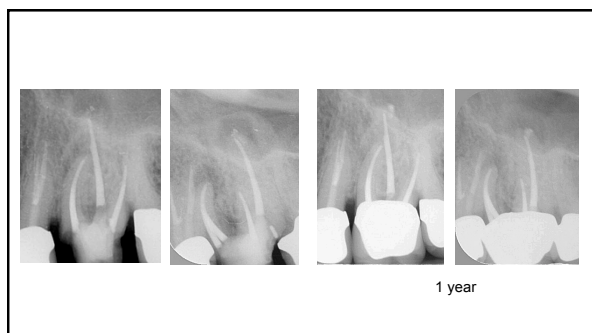
[www.brasseler.com](http://www.brasseler.com)

### Endosequence root repair material putty

- **Biocompatibility and cytotoxicity similar to MTA**  
*Alanezi et al. 2010, Damas et al. 2011, Ma et al. 2011, Hirschman et al. 2012, Ciasca et al. 2012*
- **Bioactivity similar to MTA**  
*Shokouhinejad et al. 2012*
- **Antibacterial against E. faecalis** *Zhang et al. 2009,*  
*comparable to MTA Lovato et al. 2011*
- **More cytotoxic and less bioactive than MTA**  
*Modareszadeh et al. 2012, De-Deus et al. 2012*



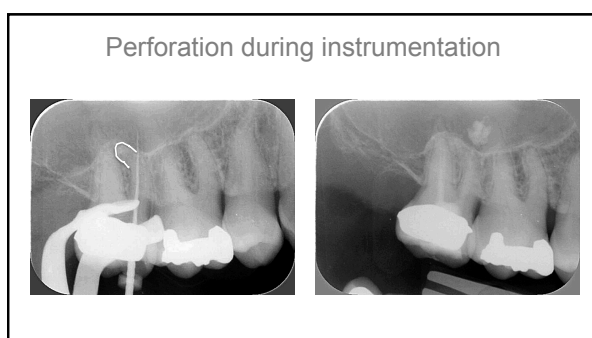




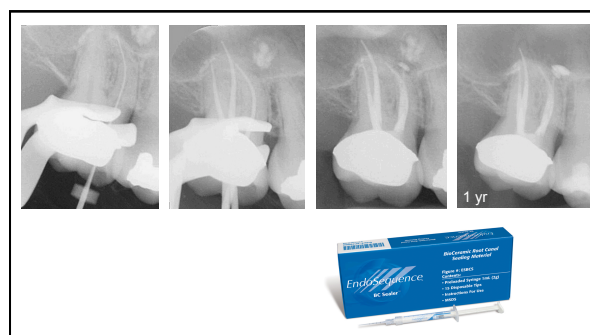
### Endosequence BC sealer/Smart Paste Bio

- Radiopacity < AH Plus
- pH > AH Plus up to 10 days after application
- Flow > AH Plus
- Release Ca<sup>2+</sup> ions > AH Plus
- Bonding to dentin: ≥ AH plus
- Apical seal with single cone or continuous wave ≈ AH Plus
- Cytotoxicity < AH Plus and Tubliseal
- Removal ≈ AH Plus

Zhang et al. '09, '10, Ersahan & Aydin '10, Zoufan et al. '11, Sağsen et al. '11, Nagas et al. '12, Candeiro et al '12



### Perforation during instrumentation



### Bioceramic sealers and putties

- In general calcium silicate and MTA-based sealers and putties
- Hydrophilic setting properties, high pH
- Dimensional stable
- Variable setting time (4-12 hours, up to 1 week)
- Similar cytotoxicity levels and biocompatibility to MTA
- Very limited evidence on sealing ability
- No long-term results

### Summary

- Location of perforation and time lapse are important prognostic factor
- Perforations in the critical zone are susceptible to periodontal breakdown
- MTA provides an effective seal of subcrestal root perforations, allows overgrowth of cementum, and promotes PDL regeneration
- Bioceramic materials seem promising, but we need more evidence to advocate their use

