

Endodontics Enriched:
WHAT COULD I BE DOING BETTER?
BUILDING UPON SUCCESS

1

Building Upon Success

- Four questions must be answered prior to initiating treatment:
  - ✓ Is the existing problem of dental origin?
  - ✓ Are the pulpal tissues within the tooth pathologically involved?
  - ✓ Why is the pulpal pathosis present?
  - ✓ What is the appropriate form of treatment?
- Information acquisition and collation through SOAP
  - ✓ Subjective
  - ✓ Objective
  - ✓ Appraisal
  - ✓ Plan

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Building Upon Success

- Subjective: patient "interview" LISTEN!!
  - ✓ CC: What brought the patient to the office
  - ✓ PMH: Review Cardio, Pulmonary, GI/Renal, Hemotologic, Nuerologic
    - ➢ Systemic etiology for presenting S/S
    - ➢ Existing disease / medication mimic odontogenic presentations
  - ✓ DH / HPDP (History of the Present Dental Problem)
    - Recent / current Rest/Perio/Ortho treatment
    - Recent changes in local area ("pimple", tenderness)
- Pain assessment questions using CLIP©

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Building Upon Success

- Commencement
  - ✓ When did the sensitivity / pain first occur?
  - ✓ What were you doing at the time?
    - Eating, drinking
    - Sleeping
- Localization
  - ✓ Patient points to specific tooth
    - Focuses diagnostic testing and etiology
- Intensity / Duration
  - ✓ Tolerable vs. life-altering (pain meds?)
  - ✓ Duration: seconds vs. minutes vs. hours
- Provocation / Relief
  - ✓ Stimulus required (chewing, cold drink, posture)
  - ✓ What relieves it, if anything

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Building Upon Success

- Objective:
  - ✓ Extra-oral exam:
    - Swelling / bruising, sinus tracts
    - Distortion of nasolabial fold, closing of the eye, facial asymmetry, distension of the floor of the mouth, lymphadenopathy
  - ✓ Intra-oral exam:
    - Location of swelling: MBF, Palatal, Lingual
    - Sinus tract (ALWAYS TRACE!!)
    - Palpation, percussion, biting
    - Mobility
    - Periodontal probing of suspected quadrant

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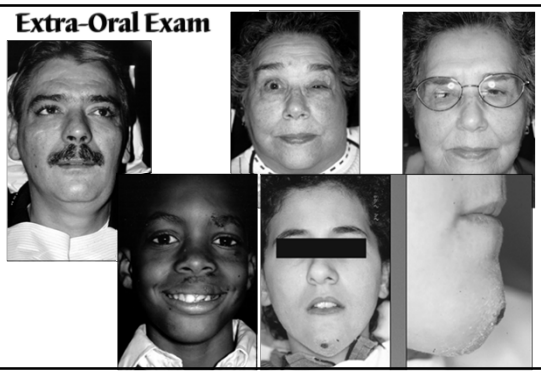
Extra-Oral Exam



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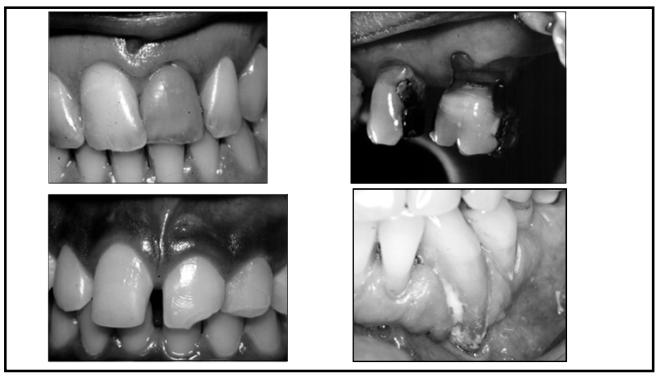

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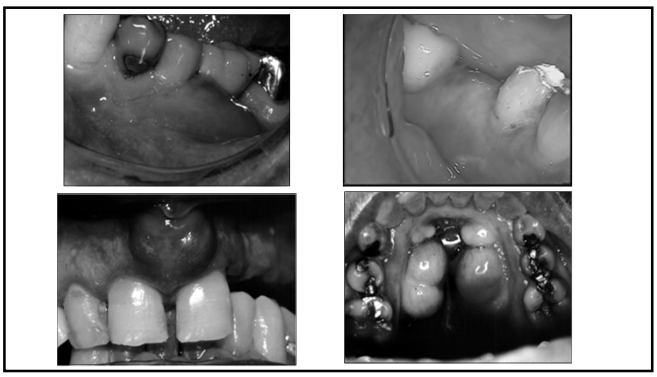

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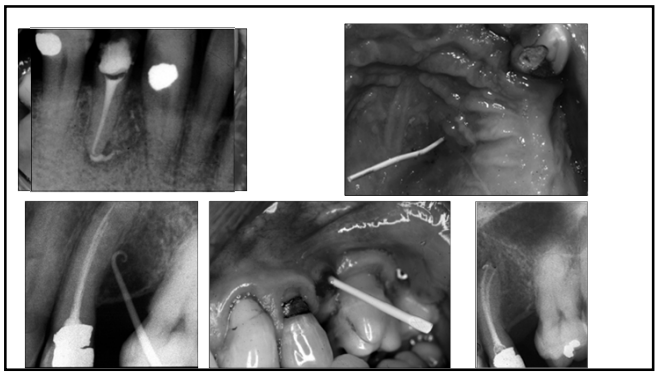

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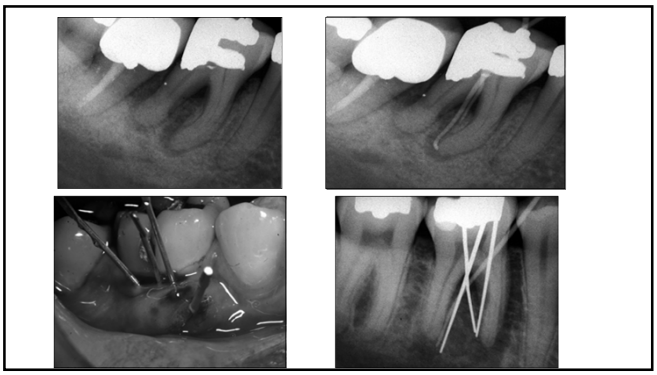

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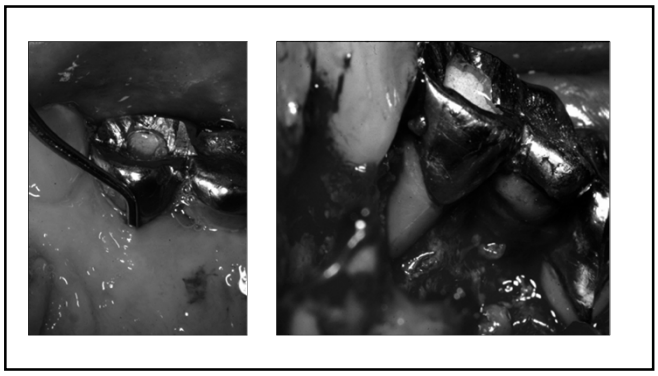

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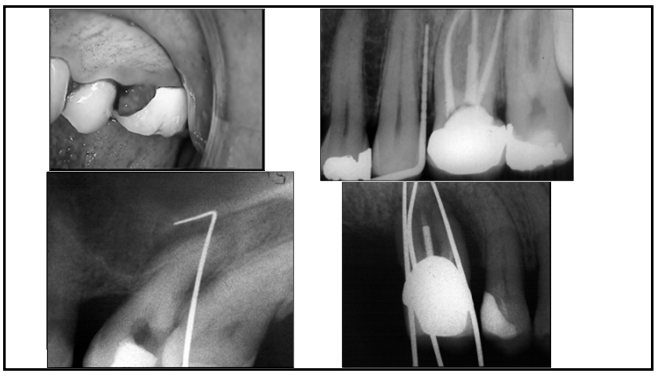

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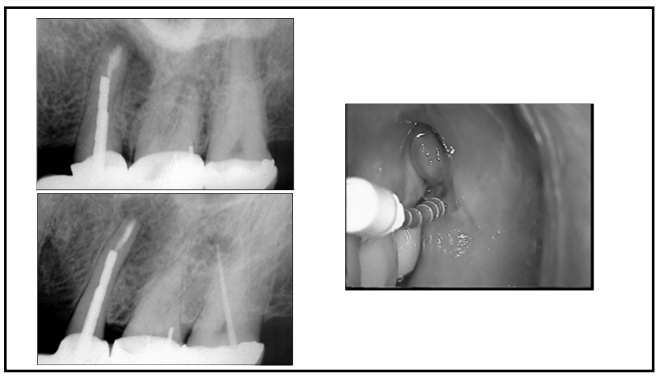

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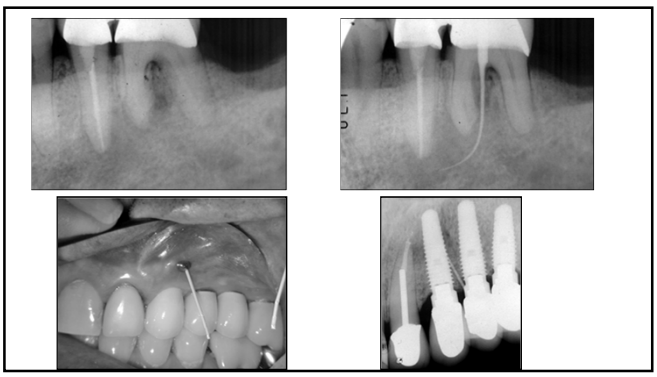

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Building Upon Success

Tests:

MIMIC THE SYMPTOMS!!!

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Building Upon Success

- Thermal: Heat vs. Cold
  - ✓ Response (or lack of), intensity, duration
  - ✓ Heat difficult to test (RD isolation)
  - ✓ Cold (CO_2 stick / refrigerant spray) applied from incisal edge to mid-facial of crown (avoid soft tissue)
  - ✓ Test contra-lateral tooth, if possible, for control
  - ✓ Combine cold test with EPT for most accurate assessment
    - Petersson K, Soderstrom C, Kiani-Anaraki M, Levy G: *Evaluation of the ability of thermal and electric tests to register pulp vitality.* Endodon Dent Traumatol 1999; 15:127
    - 93% combined accuracy for vital pulps (A-Δ and C fibers)

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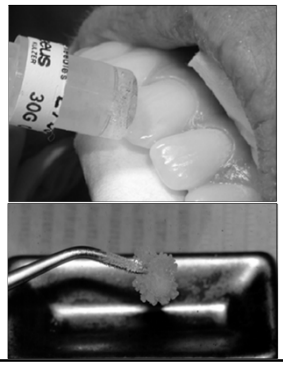
Thermal Tests



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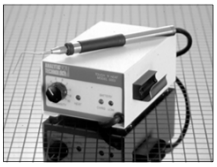
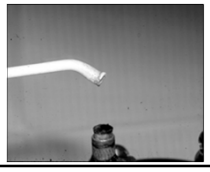
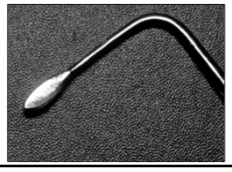
Thermal Tests

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Building Upon Success

- EPT (Electric Pulp Test):
  - ✓ NOT a qualitative measurement of pulpal health!
  - ✓ "All or Nothing" response
  - ✓ Stimulation of peripheral A- Δ fibers (sharp response, myelinated)
    - Immature teeth / apices?
  - ✓ Integrity of the circuit
    - Prosthetics, fractures, moisture
  - ✓ Use contra-lateral tooth as control, if possible
  - ✓ Patients / Pacemakers?
  - ✓ Adjust rate for slow progression, repeat 2X/tooth

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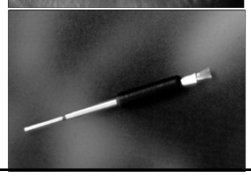
Electric Pulp Test (EPT)





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Building Upon Success

- Radiographs:
  - ✓ Several angles; vertical, horizontal, BW's
  - ✓ Presence / absence of Periapical Pathology (PAP)
  - ✓ Emulsion film vs. Digital
  - ✓ Digital 2D vs. Digital 3D (CBVT)
- Crown-Root Cracks / Fractures:
  - ✓ Generation: Occlusion vs. Dentistogenic
    - Occlusion=Mesial - distal propagation
    - Dentistogenic=Buccal(Facial) –Linqual (Palatal)
  - ✓ Radiographs?
  - ✓ CBVT?
  - ✓ SOM?

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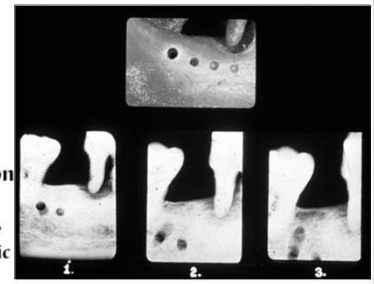
Building Upon Success

- Expose *at least* two different views
  - ✓ Mesial-distal
  - ✓ Coronal-apical
- Cortical plate density determines visualization of PAP
  - ✓ 50% of plate needs to be resorbed for radiographic changes



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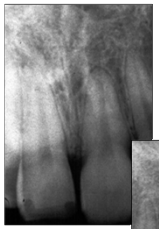


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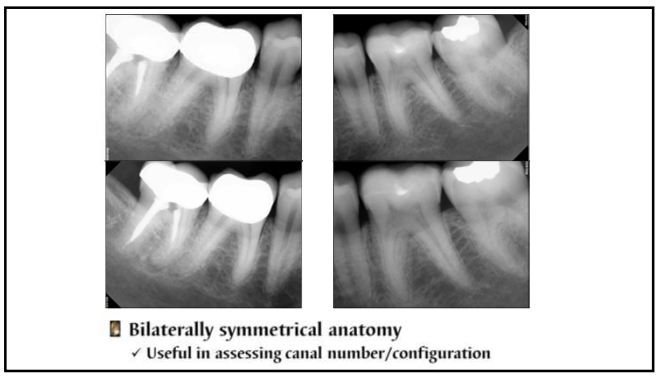

- Bilaterally symmetrical anatomy
  - ✓ Useful in assessing canal number/configuration

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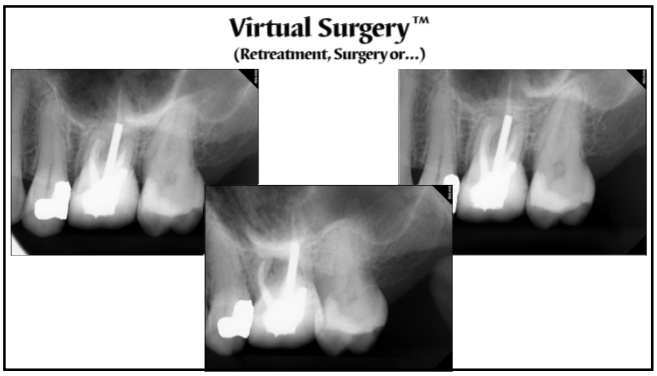

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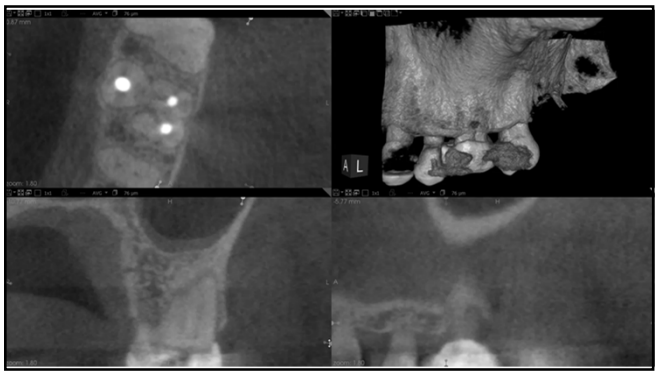

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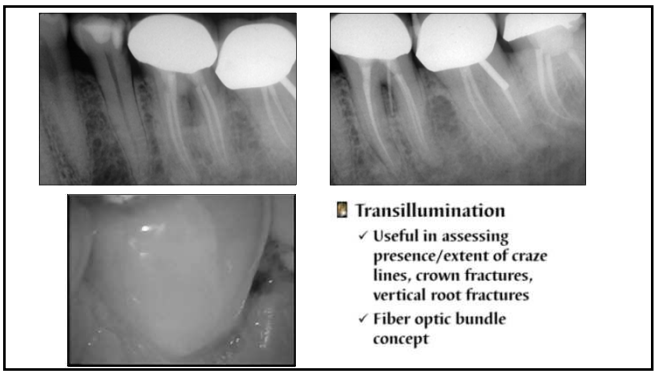

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Building Upon Success

- Classification of Pulpal Disease

Normal:

- ✓ No spontaneous symptoms / pain
- ✓ Mild reaction to thermal tests; no lingering
- ✓ Normal radiographs / tests
- ✓ No treatment

Reversible Pulpitis:

- ✓ No spontaneous symptoms / pain
- ✓ Stronger response to thermal tests, but resolves quickly
- ✓ Caries, trauma, restorative
- ✓ Dentin Hypersensitivity

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Building Upon Success

- Classification of Pulpal Disease

Irreversible Pulpitis: Symptomatic vs. Asymptomatic

Symptomatic:

- History of spontaneous pain
- Exaggerated response to thermal (sharp), lingering
- Slight thickening of the PDL periapically in advanced cases
- Deep caries / pulp exposure

Asymptomatic:

- Exaggerated response to thermal (sharp), lingering
- Deep caries (insulative?)

✓ Both require RCT; eventual necrosis of pulpal tissues

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Irreversible Pulpitis

- Coronal inflammation leads to periapical edema: thickened PDL
- Focal Sclerosing Osteitis (~~Cond. Osteitis~~): not an indication of pulpal pathology

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Irreversible Pulpitis

- Conservative excavation of teeth w/o irreversible symptoms
  - ✓ No history of spontaneous pain / lingering thermal pain
  - ✓ Procedure rendered under RD: exposure
- Restored with fluid-proof seal

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Building Upon Success

- Classification of Pulpal Disease

Necrosis:

- No response (multi-rooted teeth?)
- Initial symptoms may be absent
- Later symptoms: Percussion / Biting sensitivity
- Hypersensitivity to heat (?)
- Radiographs: thickened PDL to PAP

✓ Requires treatment when diagnosed because of the potential to spread periapically and influence systemic health

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Building Upon Success

- Classification of Pulpal Disease

Previous Root Canal Therapy:

- Presence of root canal filling materials
- Extra/missed canal spaces?

Previously Initiated Therapy:

- Partial endodontic therapy ie; pulpotomy, pulpectomy
- Adequate access/canal discovery?

✓ Requires treatment when diagnosed because of the potential to spread periapically and influence systemic health

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Building Upon Success

- Classification of Periapical Disease

  Periapical Periodontitis: Acute vs. Chronic

  ✓ Acute:
  - Painful to biting / percussion
  - Widened PDL but no PAP (Late-stage Necrosis?)
  - Vitality tests?

  ✓ Chronic:
  - No symptoms (incidental finding)
  - No response to tests
  - No sensitivity to biting
  - PAP (slight)

  ✓ Same tooth can vacillate between Acute and Chronic stages!

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Building Upon Success

- Classification of Periapical Disease

  ✓ Periradicular Abscess: Acute vs. Chronic

  ✓ Acute:
  - Extremely painful to biting / percussion / palpation
  - No response to tests; varying degrees of mobility
  - Swelling may be present intra/extra orally
  - Widened PDL to PAP
  - Patient febrile, fatigued, lymphadenopathy

  ✓ Chronic:
  - Asymptomatic
  - Long-standing infection: sinus tract, PAP

  ✓ Both can precipitate localized paresthesia

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Acute Periradicular Abscess

(Necrotic tooth)

- Treatment recommended 2 years previous; patient elected to "wait until it hurts"
- Initial diagnosis was Irreversible Pulpitis with Acute Periapical Periodontitis
  - ✓ Slightly widened PDL at the mesial #18; defective restoration, caries #17
- Multiple reminders sent to the patient during the next 6 months, ceased after 1 year
- Places emergency call to office on Christmas Eve (spouse)
- Patient febrile; "Thousand-Yard stare"

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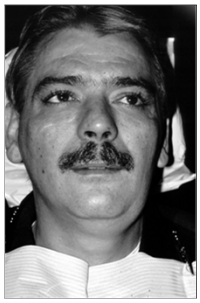
Acute Periradicular Abscess

(Necrotic tooth)



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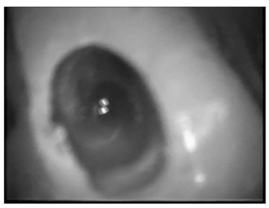
Acute Periradicular Abscess

(Necrotic tooth)



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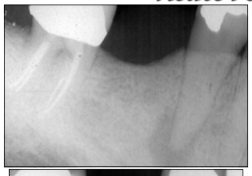
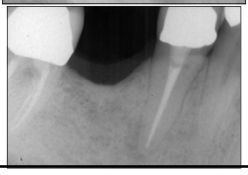
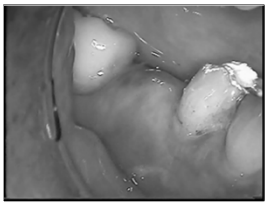
Acute Periradicular Abscess

(Necrotic tooth)







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Chronic Periradicular Abscess

(Necrotic tooth)

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Building Upon Success

- Appraisal:
  - ✓ Based on the Subjective and Objective findings, a pulpal / periapical diagnosis is made
    - Distinction between odontogenic and non-odontogenic
  - ✓ Treatment proposals based on eliminating the etiology and addressing the patients CC
    - May entail RCT or Extraction, based on non-odontogenic factors (systemic complications, finances, time constraints)
  - ✓ If RCT is selected by the patient, then...
- Treatment:
  - ✓ Based on the extent of the inflammation / infection, and the elimination of the etiology

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Building Upon Success

- Treatment (Plan):
  - ✓ Reversible Pulpitis:
    - Change restoration (remove old restoration completely)
    - Verify duration and spontaneity of pain
    - Hypersensitive dentin
  - ✓ Irreversible Pulpitis (without AAP)
    - Removal of pulpal tissues in toto (pulpectomy)
    - Single visit vs. Multi visit :$Ca(OH)_2$
  - ✓ Irreversible Pulpitis (with AAP)
    - Spread of inflammation to PA tissues
    - Multi visit, $Ca(OH)_2$, occlusal adjustment (ParaFuncHabit)
    - No antibiotics req'd

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Building Upon Success

- Treatment (Plan):
  - ✓ Necrosis / Previous RCT with APA; no swelling
    - Tx / ReTx to remove necrotic tissue / prosthetics
    - Anticipate drainage; allow time for physiologic expression, if present (canal must be dry to close)
    - $Ca(OH)_2$ treatment until symptoms reduce / resolve
    - Antibiotics if patient is febrile or demonstrates systemic S/S
  - ✓ Necrosis / Previous RCT with APA; swelling
    - Same treatment augmented by I&D if drainage not obtained through tooth (left open?)
    - Abscess vs. Cellulitis, Penrose drain vs none
    - Antibiotics for pronounced swellings / patients at risk

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Building Upon Success

- Treatment(Plan):

Cracked Teeth:

- ✓ Eliminate fracture line through restorative treatment, if possible

Extent: Enamel > Dentin > CEJ > Floor of the Chamber > Canal Orifice > Sub-Osseous

- ✓ Below the CEJ: Extraction, (based on empirical observations) especially when accompanied by discreet periodontal probing depths
- ✓ Above the CEJ: Full coverage restorations ASAP
  - Evaluate pulpal diagnosis prior to placement

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Building Upon Success

AAE Endodontic Case Difficulty Assessment Form

Criteria and Subcriteria	Minimal Difficulty	Moderate Difficulty	High Difficulty
A. PATIENT CONSIDERATIONS			
Medical history	☐ No medical problem (ASA Class 1*)	☐ One or more medical problems (ASA Class 2*)	☒ Complex medical history/serious illness/disability (ASA Classes 3-5*)
Anesthesia	☐ No history of anesthesia problems	☒ Vasoconstrictor intolerance	☒ Difficulty achieving anesthesia
Patient disposition	☐ Cooperative and compliant	☐ Anxious but cooperative	☒ Uncooperative
Ability to open mouth	☐ No limitation	☐ Slight limitation in opening	☐ Significant limitation in opening
Gag reflex	☐ None	☐ Gags occasionally with radiographs/treatment	☐ Extreme gag reflex which has compromised past dental care
Emergency condition	☐ Minimum pain or swelling	☐ Moderate pain or swelling	☒ Severe pain or swelling

Source: American Association of Endodontists, 211 E. Chicago Ave., Suite 1100, Chicago, IL 60611-2691

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IDERATIONS	
agnosis of oms required	☒ Confusing and complex signs and symptoms: difficult diagnosis ☐ History of chronic oral/facial pain
adiographs uth, narrow sence of tori)	☒ Extreme difficulty obtaining/interpreting radiographs (*e.g.*, superimposed anatomical structures)
(0-30°) 30°)	☐ 2nd or 3rd molar ☒ Extreme inclination (>30°) ☐ Extreme rotation (>30°)
odification n isolation	☒ Extensive pretreatment modification required for rubber dam isolation
n m normal aurodontism, ronal	☒ Restoration does not reflect original anatomy/alignment ☒ Significant deviation from normal tooth/root form (*e.g.*, fusion, dens in dente)

Source: American Association of Endodontists, 211 E. Chicago Ave., Suite 1100, Chicago, IL 60611-2691

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Building Upon Success

CANAL AND ROOT MORPHOLOGY	☐ Slight or no curvature (<10°) ☐ Closed apex (<1 mm in diameter)	☐ Moderate curvature (10-30°) ☐ Crown axis differs moderately from root axis. Apical opening 1-1.5 mm in diameter	☒ Extreme curvature (>30°) or S-shaped curve ☐ Mandibular premolar or anterior with 2 roots ☒ Maxillary premolar with 3 roots ☒ Canal divides in the middle or apical third ☐ Very long tooth (>25 mm) ☒ Open apex (>1.5 mm in diameter)
RADIOGRAPHIC APPEARANCE OF CANAL(S)	☐ Canal(s) visible and not reduced in size	☐ Canal(s) and chamber visible but reduced in size ☐ Pulp stones	☒ Indistinct canal path ☐ Canal(s) not visible
RESORPTION	☐ No resorption evident	☐ Minimal apical resorption	☒ Extensive apical resorption ☒ Internal resorption ☒ External resorption

Source: American Association of Endodontists, 211 E. Chicago Ave., Suite 1100, Chicago, IL 60611-2691

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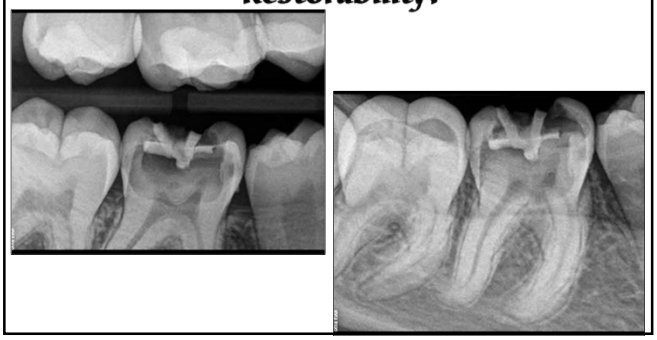
Restorability?



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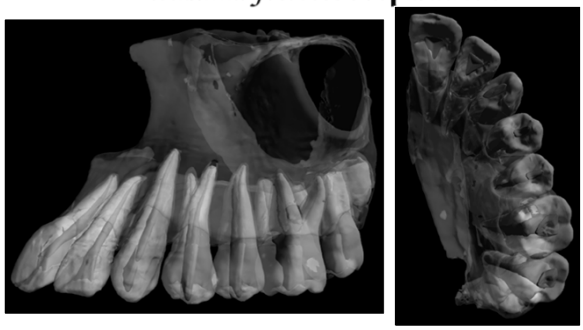
Maxillary Access Preparations



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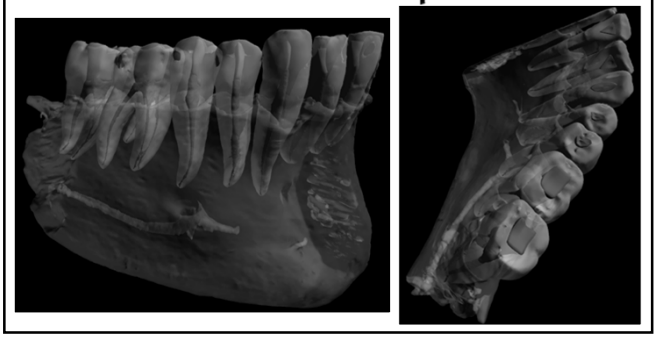
Mandibular Access Preparations



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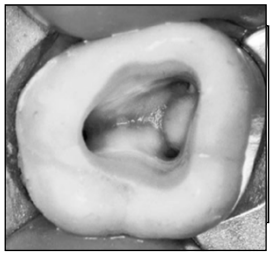
Access Cavity Requirements



- Permit removal of entire chamber contents
- Enable complete, direct vision of pulp chamber floor and orifices

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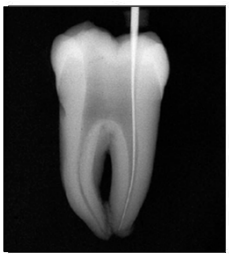
Access Cavity Requirements



- Permit removal of entire chamber contents
- Enable complete, direct vision of pulp chamber floor and orifices
- Facilitate introduction of endodontic instruments into radicular pulp
- Provide straight-line access

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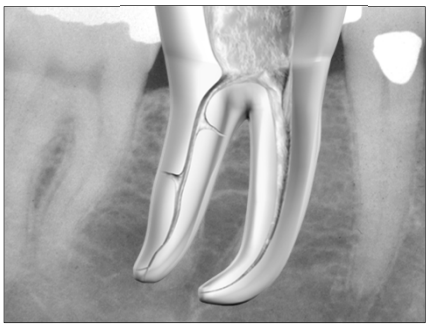

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Building Upon Success

- Rubber dam isolation
  - ✓ Restore prior to clamp placement if tooth structure insufficient for fluid-proof seal
    - Clamp adjacent teeth, if required
  - ✓ Complete caries excavation prior to pulp exposure
  - ✓ Verify security of clamp placement
    - Crowns (permanent / temporary), questionable restorations
  - ✓ Verify correct tooth is isolated!
  - ✓ Latex allergy
  - ✓ When possible, place post / core while RD is in place

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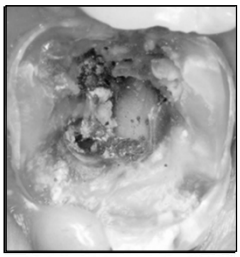
Access Cavity Requirements



- Provide a positive support for temporization
- Always have four walls
  - ✓ Pre-emptive restoration

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Building Upon Success

- The four "R's" of successful Endodontic therapy:
  - ✓ Remove: soft tissue (affected/infected), hard tissue (dentin, size/taper)
  - ✓ Refine: chemical digestion/agitation, antibacterial rinses
  - ✓ Replace: Create a coronal / apical barrier to inhibit re-infection into the canal system
  - ✓ Restore: Prevent microleakage, increase structural integrity

59

Endodontic Outcomes:

To improve the success of the therapy, changes need to be realized in the basic components:

- Instrumentation
  - ✓ More efficient : time, cutting ability
  - ✓ Minimize negative events (separation)
- Irrigation
  - ✓ More efficient : time vs. toxicity
  - ✓ Convenient, stable, host tolerable
- Obturation
  - ✓ Easily placed/removed
  - ✓ Seals completely *

60

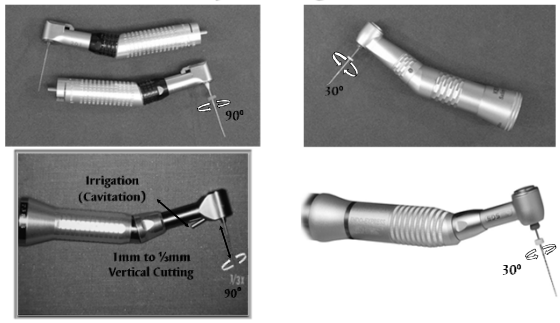
Endodontic Outcomes:

To improve the success of the therapy, changes need to be realized in the basic components:

- Instrumentation
  - ✓ More efficient : time, cutting ability
  - ✓ Minimize negative events (separation)

61

Reciprocating Movements



62

Principles of Cleaning / Shaping

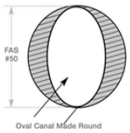
LSX Final Apical Sizing (FAS) Guide

Figure B
Most Common Final Apical Sizes (FAS)

Tooth Name	Final Apical Size (Most Common)	Final Apical Size (Range)
MAXILLARY		
Central & Lateral	70	50 - 140
Canine	90	55 - 120
Premolar	60	35 - 100
Molar - MB	55	35 - 110
Molar - DB	60	35 - 90
Molar - P	70	40 - 120
MANDIBULAR		
Tooth Name	Final Apical Size (Most Common)	Final Apical Size (Range)
Incisor	60	60 - 80
Canine	70	70 - 110
Premolar	70	40 - 100
Molar - MB	55	30 - 110
Molar - ML	55	35 - 90
Molar - P	70	35 - 120

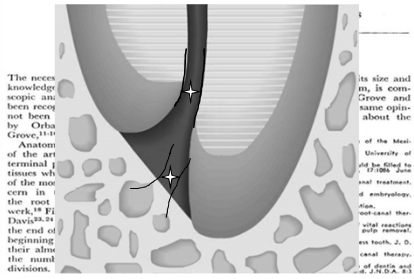
Figure C
Apical Cross-Section

The goal is to touch (clean) all walls of the oval canal to make it round.



63

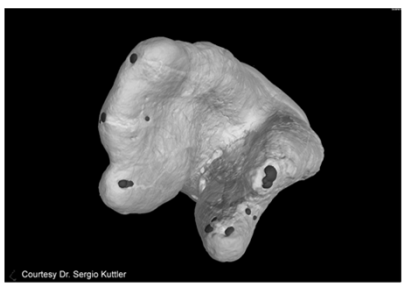
Root Canal Anatomy



Kuttler Yury; "Microscopic investigation of the root apexes"
JADA; vol. 50, no. 5, pg. 544-552, May 1955

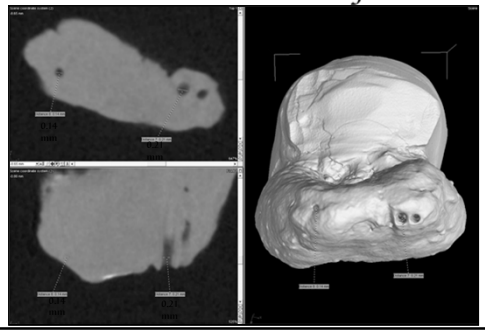
64

Root Canal Anatomy



65

Root Canal Anatomy

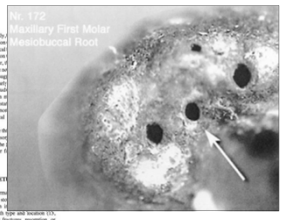


66

Root Canal Anatomy

Morphology of the Physiological Foramen: I. Maxillary and Mandibular Molars

Benjamin Briseño Marroquín, Prof. Dr. med.dent., Mohammed A. A. El-Sayed, Dr. med.dent., and Brita Willershausen-Zönnchen, Prof. Dr. med.dent.



Information concerning the anatomy of the physiological foramen is limited. The aim of this study was to investigate the distance between the physiological and anatomical apex, accessory foramina frequency, and the shape and diameter of the physiological foramen in maxillary and mandibular molars. The apical anatomy of 523 maxillary and 574 mandibular molars from an Egyptian population was investigated by means of a computer-aided stereomicroscope (40× magnification). The following results were obtained:

(a) There was a high percentage of two physiological foramina in mesial (67.06%) and mesiobuccal (71.15%) roots of mandibular and maxillary first molars, respectively.
(b) There was a high frequency of accessory foramina in maxillary mesiobuccal (30%) and mandibular mesial (26%) roots.
(c) The most common physiological foramen shape was oval (70%).
(d) The mean of the narrow and wide physiological foramen diameters was as follows:
- 0.20 to 0.26 mm in mandibular molars
- 0.18 to 0.20 mm in the maxillary mesiobuccal and distobuccal root
- 0.22 to 0.29 mm in the maxillary palatal root

JOE, Vol. 30, No. 5, pg. 321-328, May 2004

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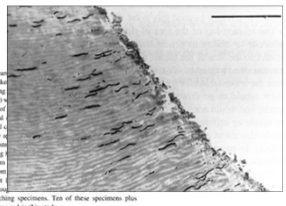
Root Canal Anatomy

Regional Variation in Root Dentinal Tubule Infection by *Streptococcus gordonii*

Robert Matthew Love, MDS



The purpose of this study was to investigate the pattern of bacterial invasion of dentinal tubules at different regions in human roots. Specimens were obtained from single-rooted teeth that had their root canals prepared in a standard manner. Roots were then sectioned longitudinally through the canals and the resulting specimens chemically treated to remove the smear layers. Specimens were immersed in a suspension of *Streptococcus gordonii* for 3 weeks and then prepared for histological analysis. Sections from the cervical, midroot, and apical areas were examined. The pattern of bacterial infection of the cervical and midroot areas was similar, characterized as a heavy infection with bacteria penetrating as deep as 200 μm. Invasion of the apical dentin was significantly different, with a mild infection and maximum penetration of 60 μm.

JOE, Vol. 22, No. 6, pg. 290-293, Jun 1996

68

Does Apical Size Matter?

Evaluation of Apical Debris Removal Using Various Sizes and Tapers of ProFile GT Files

Lynn J. Albrecht, DDS, J. Craig Baumgartner, DDS, PhD, and J. Gordon Marshall, DMD

"Taper, rather than size, has a greater influence on the efficacy of the cleaning (irrigation)"

GT files on the ability to introduce irrigant and remove debris from root canals. Forty-eight bilaterally matched pairs of extracted teeth were instrumented using .04-, .06-, .08-, and .10-tapered files with one tooth of each pair enlarged to size #20 and the other to size #40. The teeth were sectioned at 1 mm and 3 mm from the apex, and the amount of remaining debris was calculated as a percentage of the total lumen area. The following variables were evaluated: apical preparation size, preparation taper, total volume of irrigation, depth of irrigation needle penetration, and number of instrument changes needed to reach working length. Compared with the size #40 preparations, a significantly greater percentage of remaining debris was observed in the size #20 preparations at the 1-mm level for all tapers except the .10

JOE, Vol. 30, No. 6, pag. 425-428, Jun 2004

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WaveOne Gold™ : Design Features

- Angles/RPM: 350 CPM; angles proprietary
- Sizes/Tapers:
  - ✓ #20/.07 Small)
  - ✓ #25/.07(Primary)
  - ✓ #35/ .06 (Medium)
  - ✓ #45/ .05 (Large)
- Instrument Tip: Semi-active
- Helical Angle/Pitch: Variable
- Cross Section:
  - ✓ D1 -16: Modified parallelogram shape
  - ✓ Color is post-machining heat treatment
- Single Use!
  - ✓ Handle expands upon autoclaving!

70

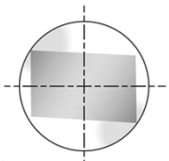
Original WaveOne® ⇨ WaveOne® Gold

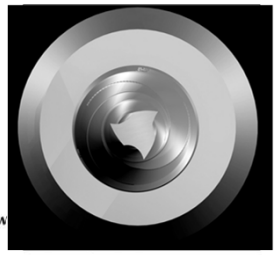
	Tip Diameter	Taper At Tip
Small	021	6%
Primary	025	8%
Large	040	8%

	Tip Diameter	Taper At Tip
Small	020	7%
Primary	025	7%
Medium	035	6%
Large	045	5%

71

WaveOne Gold™

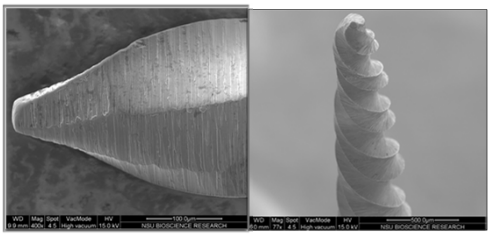




- Alternate contact points
  - ✓ Reduce the corkscrew effect

72

WaveOne Gold™ : SEM



73

WWG Small

- Employed as "scouting" file in small/convoluted canal configurations
  - ✓ Dilacertion, Bayonet

DS	Taper
.845	.045
.345 .275 .205	.07

74

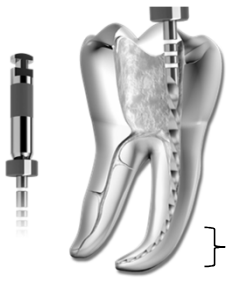
WWG Primary

- Employed as the primary negotiating/machining file
  - ✓ Pre-flaring?
  - ✓ # of insertions?

DS	Taper
.955	.06
.390 .320 .250	.07

75

WWG Medium



- Created as an "intermediate" size
  - ✓ Bridged the size gap within the sequence

DS	Taper
.945	.05
.470 .410 .350	.06

76

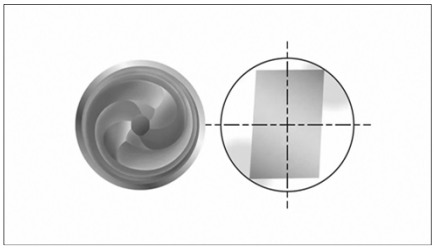
WWG Large

- Proportional size to WWGM file
  - ✓ #41 @ 1mm
- Taper = F5

DS	Taper
.895	.04
.550 .500 .450	.05

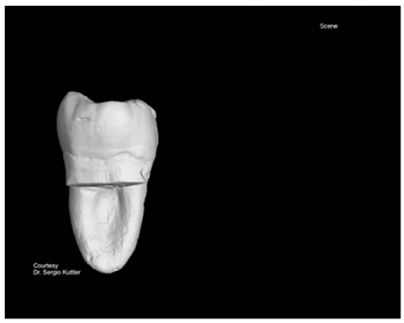
77

WaveOne Gold™: File Motions



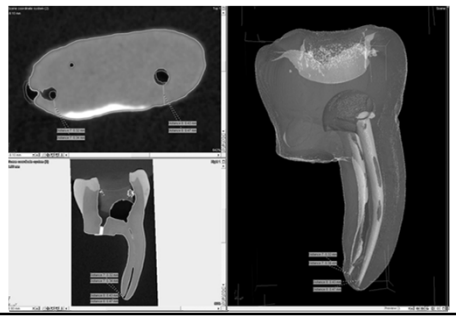
78

Micro CT: Pre-Op/Post-op



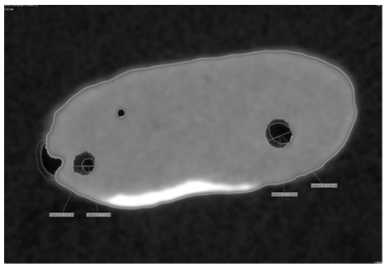
79

Micro CT: (PDL proximity)



80

Micro CT: (Apical Foramen)



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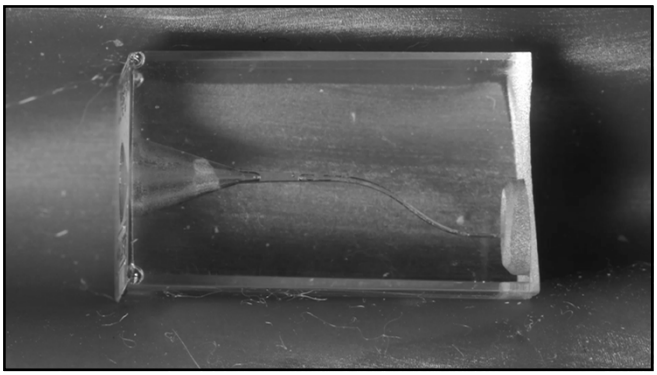


82

What is... and Why Create a Glide Path

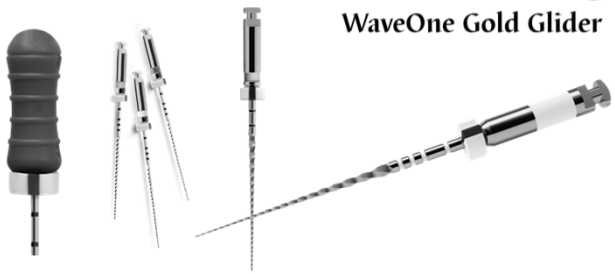
- "...preflaring is necessary to minimize the chance of permanently blocking a canal with a broken rotary instrument."

83

Glide Path Options

Hand files Pathfiles ProGlider

WaveOne Gold Glider



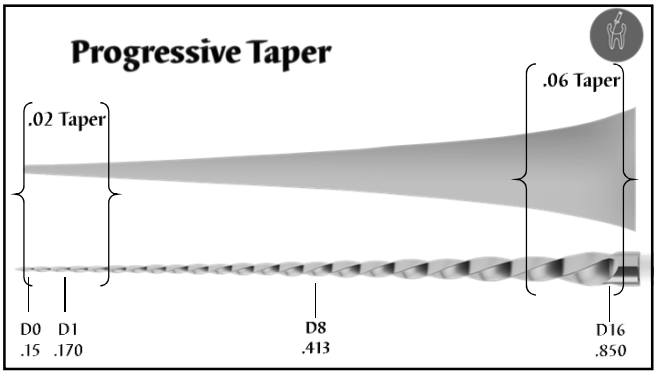
84

Wave One Gold Glider™

- M-Wire® NiTi with heat treatment
- 21, 25 and 31 mm length
- Tip - .15
- Progressive Taper (2% - 6%)
- Identical reciprocation motion to WWG
- Parallelogram cross section/variable helical angles
- 16 mm active cutting zone
- 3-pack
- Single Patient Use

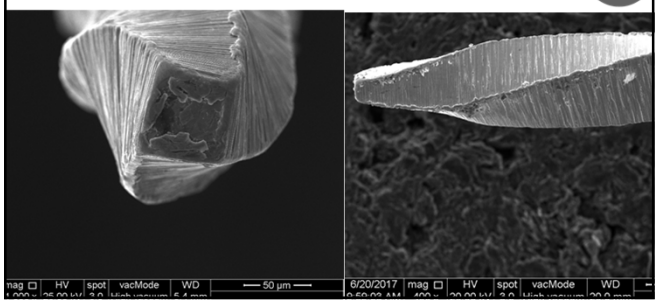
85

Progressive Taper



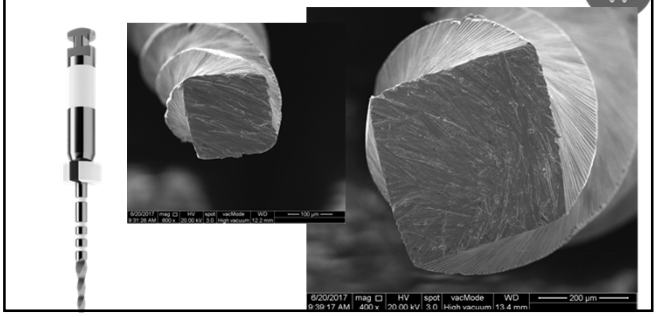
86

Semi-Active Tip – ISO 017



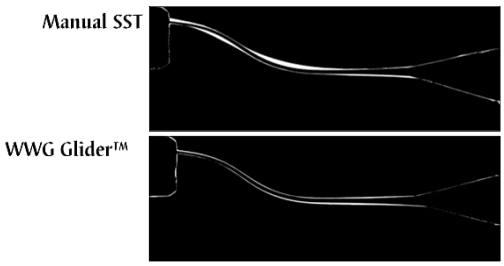
87

Off-set, Rectangular Cross Section



88

Shape Comparison



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Glide Path Creation

- Prepare straight line access to canal orifice
- Scout canal with hand file(s), to a size 10
- Establish working length and confirm patency
- Irrigate canal space
- Use Wave One Gold Glider™ in one or more passes, until full working length is reached
- Irrigate expanded glide path
- Reconfirm working length before shaping canal space

90

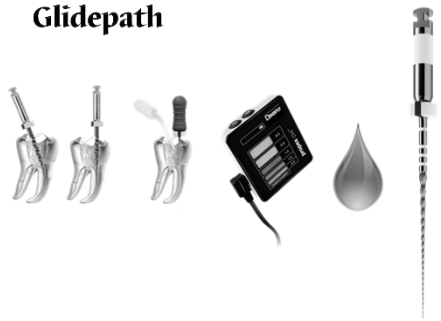
Determine Working Length

91

Irrigation

92

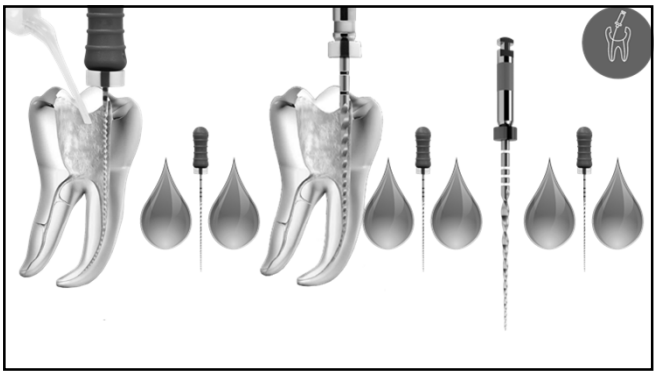
Glidepath



93

Glidepath

94



95

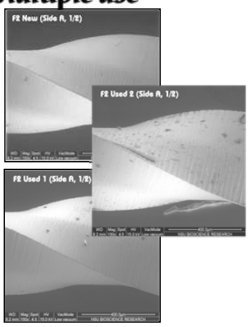
Key Learnings

- Active Instruments are More Efficient
- Varying Tapers Imparts Optimal Shapes
- Thermal Treatments Improve Flexibility and Fatigue Resistance
- Always Establish a Glidepath
- Apply Minimal Pressure
- Clean Instrument Frequently

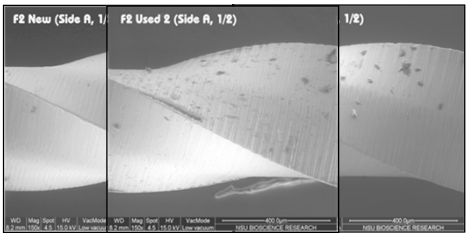
96

Single vs. Multiple use

- Instrument wear
- Mechanical properties
  - ✓Cyclic fatigue
  - ✓Torsional resistance
- Cutting efficiency
- Corrosion
- Sterilization



97



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Metallurgic Considerations - Cyclic Fatigue

Build up of tension within NiTi rotary instruments depends on instrument diameter.

Effect of Cyclic Fatigue on Static Fracture Loads in ProTaper Nickel-Titanium Rotary Instruments

Cheryl J. Ullmann, cand med dent, Ove A. Peters, PD, Dr med dent, MS FICD

JOE, Vol. 31, No. 3, pg. 183-186, Mar. 2005

99

Metallurgic Considerations - Corrosion

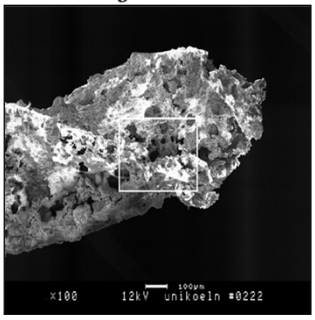
Atomic force microscopy three-dimensional images and roughness values indicated that short-term contact between NaOCl and EDTA caused alterations in the surface of instruments.

Effects of sodium hypochlorite and ethylenediaminetetraacetic acid on rotary nickel-titanium instruments evaluated using atomic force microscopy

IEJ, Vol. 44, No. 3, pg. 203-209, Mar. 2011

100

Metallurgic Considerations



101

Metallurgic Considerations

Nickel-titanium rotaries have reduced resistance to cyclic fatigue after contact with heated NaOCl and may then be considered single-use instruments.

Effect of Immersion in Sodium Hypochlorite on Torque and Fatigue Resistance of Nickel-Titanium Instruments

Ove A. Peters, PD, Dr. med dent MS, Jan O. Roehlike, Dr. med dent, Michael A. Baumann, Prof. Dr. med dent

JOE, Vol. 33, No. 5, pg. 589-593, May 2007

102

Metallurgic Considerations

- There is an overwhelming evidence of the metallurgic property changes in all aspects of endodontic instruments during root canal preparation
- The complexity of tooth anatomy that endodontic instruments works on (3D curvatures, curvatures degrees and radius)
- The chemical effects that irrigation solutions produce on root canal instrument surfaces
- The continuous rearrangements of the crystals of NiTi during sterilization cycles
- The "cost" benefit of single use vs. multiple uses, outweighs all risks in the decision making of endodontic instrument failure

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WaveOne™ : Single Use

Prion Protein (PrP) in Human Teeth: An Unprecedented Pointer to PrP's Function

Kurt Schneider, Yüksel Korkmaz, DDS,* Klaus Addicks, MD, PhD,† Hermann Lang, DDS, PhD,* and Wolfgang H.-M. Raab, DDS, PhD**

Periodontal and pulpal tissue exposed by disease or trauma might represent a clinically relevant entry point for prions incorporated orally and thus a possible mode of infection.

and pulpal tissue exposed by disease or trauma might represent a clinically relevant entry point for prions incorporated orally and thus a possible mode of infection. *J Endod 2007;33:110–113)*

Key Words
Prion protein (PrP), teeth, immunohistochemistry, SEM

We investigated the distribution of PrP in dental tissues by: (1) immunostaining of human teeth (antibody 6H4); (2) reverse transcriptase–polymerase chain reaction (RT-PCR)/Western blot (antibody 6H4) of cultured human dental pulp, periodontal ligament, and ectomesenchyme cells; and (3) scanning electron microscopy (SEM) of molars from knockout ($Prnp^{0/0}$, Zrch I), wild-type, and PrP-overexpressing rescue mice.

104

Considerations

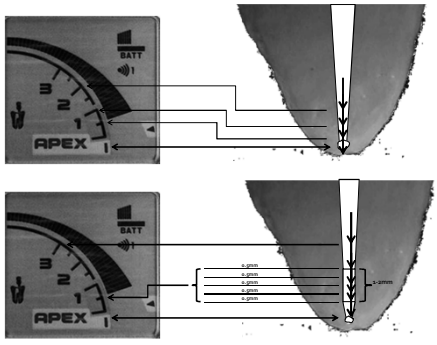
- The instrument present a clinically significant risk of disease transmission after preparation for re-use
- Changes in physical properties caused by initial use or in its initial preparation for re-use presents a clinically significant risk of instrument failure

105

Electronic Apex Locator

- More sensitive to +/- 0.5mm than Root ZX
- Activate unit prior to attaching grounding clip to patient
- Canals can be wet; no "pooling" in the chamber
- Avoid contact with metallic restorations

106



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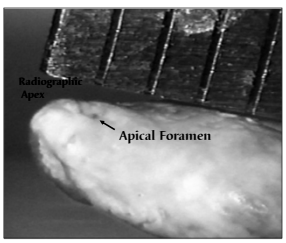

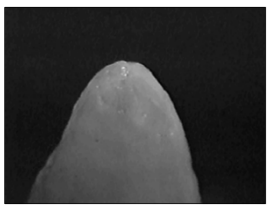

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Apex Locator Malfunction?

- Tissue connections between canals effect a "short circuit"
  - Similar to flooded access chamber

109

Endodontic Outcomes:

To improve the success of the therapy, changes need to be realized in the basic components:

- Instrumentation
  - ✓ More efficient : time, cutting ability
  - ✓ Minimize negative events (separation)
- Irrigation
  - ✓ More efficient : time vs. toxicity
  - ✓ Convenient, stable, host tolerable

110

Improving Outcomes?

"...all instrumentation techniques left 35% or more of the canal's surface area unchanged.

-O. Peters, IEJ (34) 2001

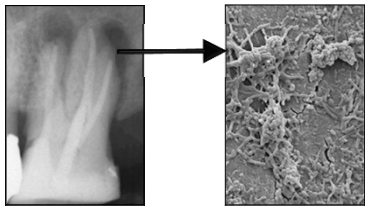
Peters OA, Schonenberger K, Laib A. Effects of four Ni-Ti preparation techniques on root canal geometry assessed by micro-computed tomography. International Endodontic Journal 2001; 34(3):221-30

111

Goals of Endodontics

Prevention and elimination of endodontic infection

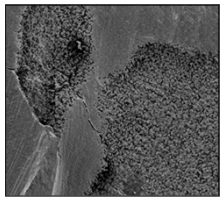
Irrigation

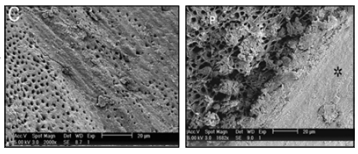


112

Irrigation

- Chemically debride canal
- Dissolve tissue
- Remove smear layer
- Kill microbes





SEMs of smear layer partially covering instrumented sections of canal walls (Dr. Franklin Tay)

113

Solutions

NaOCl	Dissolves organic tissue
	Kills microbes quickly
EDTA	No effect on inorganic tissue
CHX	Weakens in contact with other materials
	Toxic/caustic effect on PA tissue
	Harmful effect on dentin structure??

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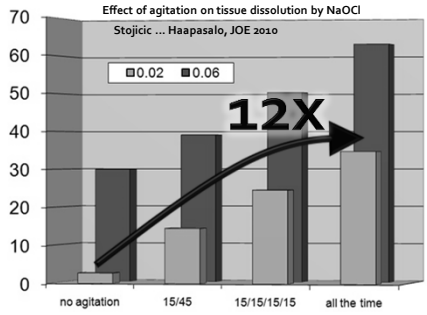
Sodium Hypochlorite



115

Sodium Hypochlorite

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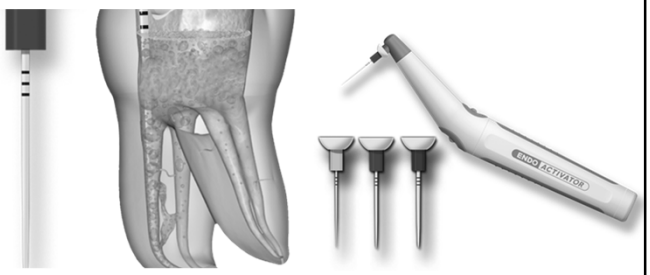
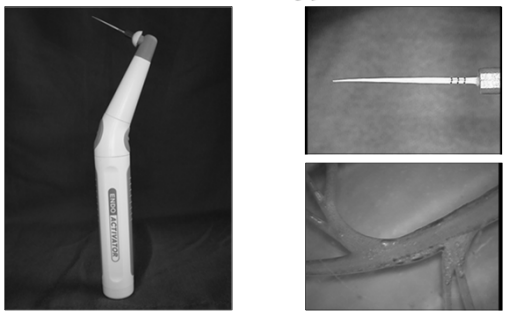
Mechanical Agitation with EndoActivator



117

Sodium Hypochlorite



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Irrigation and Disinfection Protocol

Irreversible Pulpitis | API / Necrosis / Retreatment

Throughout Shaping – Irrigation with NaOCl

After Completion of Shaping: 17% EDTA for 1 Min

H_2O Rinse
NaOCl ≥ 10 ml per Canal
H_2O Rinse
(Optional - 2% CHX)

$Ca(OH)_2$ Dressing for ≥ 7 Days

Complete Drying of Canals (Optional - Isopropyl Alcohol) Before Obturation

- Based On Recommendations From
- Baylor College Of Dentistry, Dallas, Texas, USA
- University Of Zurich Dental School, Switzerland
- University Of Freiburg, Dental School, Germany

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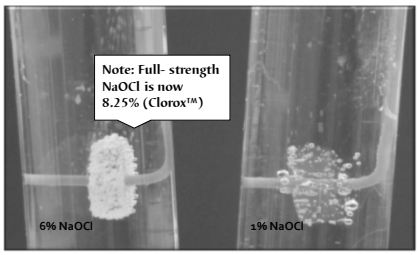
Sodium Hypochlorite



High conc. NaOCl dissolves tissue faster than low conc. solution.

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Solutions

NaOCl	Removes Smear Layer
EDTA	No Bacteria Killing
	Does Not Dissolve Soft Tissue
CHX	May Erode Dentin with Longer Time Exposure

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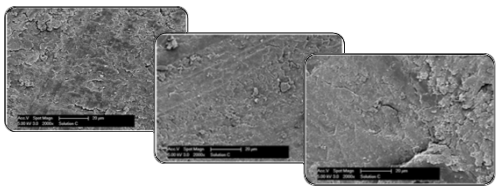
Solutions

NaOCl	Kills bacteria (not quickly)
EDTA	Improves long term dentin bonding to resins
CHX	Does not dissolve tissue
	Does not disrupt biofilm

122

Smear Layer Removal Study



5.25% NaOCl + Distilled Water as final rinse (Negative Control)

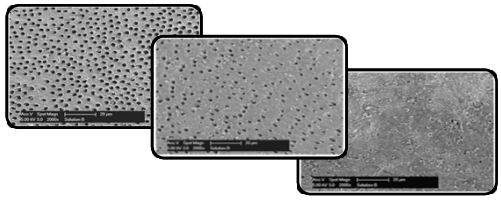
Significant amount of smear layer at all three levels of teeth

123

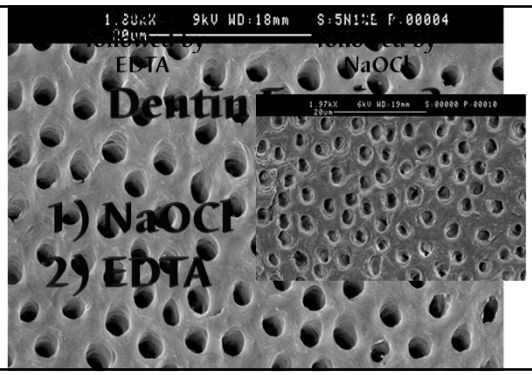
Smear Layer Removal Study

17% EDTA

- ✓ Removed smear layer at all levels of the tooth



124



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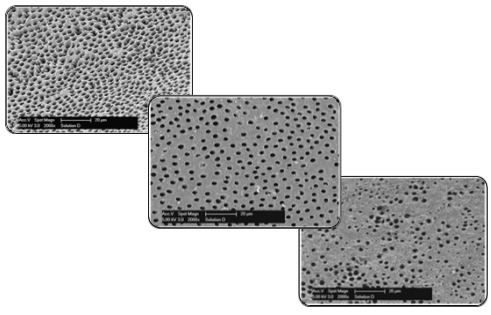
QMix™ 2in1



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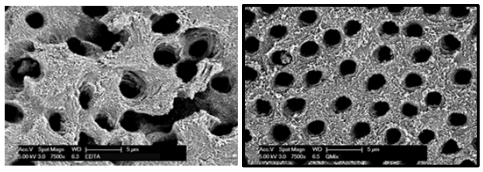
Effect of EDTA vs. QMix™ 2in1 on Dentin Surface

SEM EX-VIVO CLINICAL RESULTS



90 Seconds Final Rinse
17% EDTA

90 Seconds Final Rinse
QMix™ 2in1

Franklin R. Tay
Medical College of Georgia

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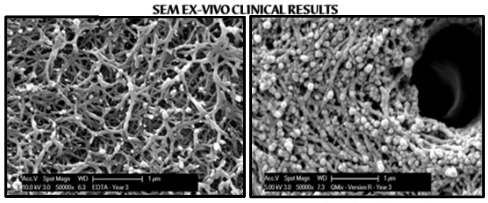
Effect of EDTA vs. QMix™ 2in1 on Dentin Surface

SEM EX-VIVO CLINICAL RESULTS



NaOCl and EDTA

NaOCl and QMix™ 2in1

Franklin R. Tay
Medical College of Georgia

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Endodontic Outcomes:

To improve the success of the therapy, changes need to be realized in the basic components:

- Instrumentation
  - ✓ More efficient : time, cutting ability
  - ✓ Minimize negative events (separation)
- Irrigation
  - ✓ More efficient : time vs. toxicity
  - ✓ Convenient, stable, host tolerable
- Obturation
  - ✓ Easily placed/removed
  - ✓ Seals completely

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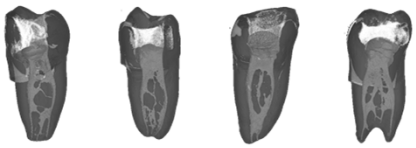

Challenge: Can we completely clean and disinfect these spaces?

What is the alternative?

Effective Seal

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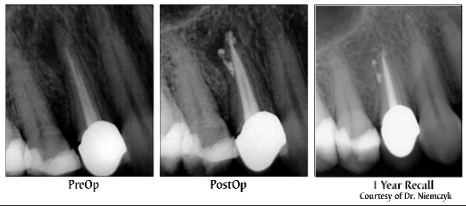
Fact: The quality of the obturation is directly related to the extent of the shaping and irrigation

Retreatment Tooth #5



PreOp PostOp 1 Year Recall

Courtesy of Dr. Niemczyk

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Methods and Techniques of Root Canal Obturation

- Lateral Compaction and Variations
- Vertical Compaction and Variations
- Hybrid Techniques
- System "B" Obturation System
- Obturall Injectible System
- ThermaFil® Systems
- EZ Fill System
- Microseal System
- SimpliFill™
- GuttaFlow®
- FibreFill™
- EndoREZ™
- Epiphany™- Resilon™
- *Next™*
- *Real Seal™*

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Thermafil
(Thermafil Plus, GT, ProTaper)

Benefits

- Plastic core carrier, gutta percha coated (proprietary process), vented
- Low-viscocity formula improves flow
- Thinnest sealer film (2.2µ)
- New oven (2008)
- Size verifiers (Metal, NiTi) except GT

Inconveniences

- Post space creation
- Extrusion of material (sealer?)
- Retreatment difficulties
- Potential for misuse

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Challenges:

- Post space:
  - ✓Off-angle creation
  - ✓Dislodgement
- Retreatment:
  - ✓Incomplete removal / deep severing
  - ✓Carrier resistant to cutting
- Misuse:
  - ✓"Radio-dontics" (plastic fill)
  - ✓Improper size insertion

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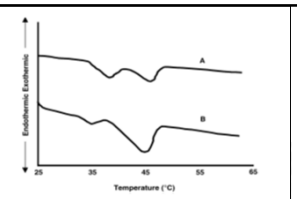
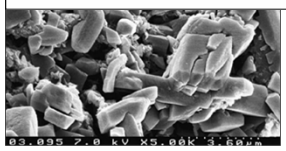
GuttaCore ™

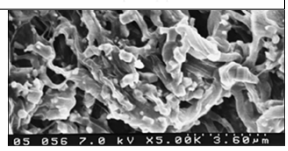
- Gutta percha: "Alpha-like" in terms of viscosity (low), flow and adhesive properties
  - ✓Fusion temperature analysis: GuttaCore 56° C
    Alpha Phase 70° C
- GuttaCore GP: reheated w/o change in physical properties
  - ✓True alpha phase undergoes irreversible changes
- GuttaCore GP: chemically beta, physically alpha
  - ✓"chewing " or vulcanisation phase of manufacturing yields very fine and homogenous reticular structure
  - ✓Disrupts long polymer chains
  - ✓Low molecular weight fragments ⇨ low viscosity (flow)

135

Combe EC et al. Alpha- and beta-forms of gutta-percha in products for root canal filling. Int Endod J, 2001;34: 447–451







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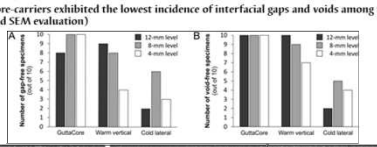
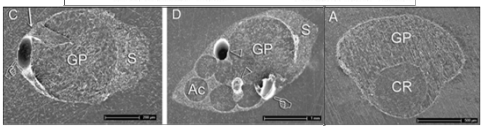
GuttaCore Research

- Franklin R. Tay et al: *Quality of obturation achieved by an endodontic core-carrier system with crosslinked gutta-percha carrier in single-rooted canals.* J of Dent 2014; 42: 1124–1134
  - ✓ GuttaCore core-carriers exhibited the lowest incidence of interfacial gaps and voids among the three groups, (Micro CT and SEM evaluation)





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Properties

GuttaCore ™

- Core more flexible
  - ➢ Easily cut/crushed
  - ➢ Less resistant to off-angle insertion
- Less insertion force
- Universal heating time
- Sever with bur/cut
- Pan-applicable obturation method
- Radio-opaque

Thermafil ™

- Plastic stiff/unbreakable
- Variable heating times
- Must be severed with a bur / heat
- Pan-applicable obturation method
- Radio-opaque

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GuttaCore®

Clinical advantages

- User-friendly technique
  - ✓ Inserting a hand file into the canal
  - ✓ Positive length control and verification
- Minimal armamentarium for WVT
  - ✓ "Endodontic Gymnastics"
- Requires strict adherence to technique protocols
  - ✓ Zero tolerance for overt vertical force
  - ✓ Size verification more critical than when employing conventional carrier = more passive flow / less extrusions

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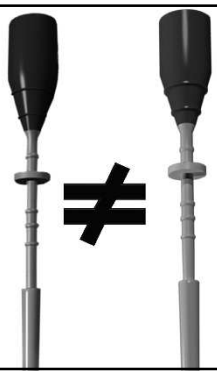
GuttaCore: Generation 1 vs. Generation 2

- Original
  - ✓ Gray Colored Gutta-percha Core
  - ✓ More Brittle



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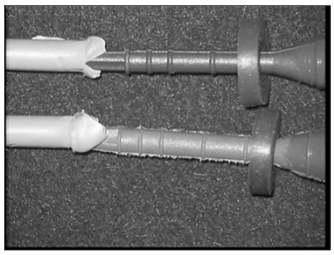
Carrier Comparison



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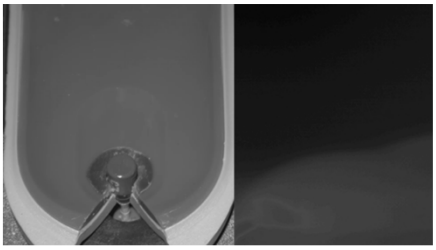
GuttaCore Thermal Profile



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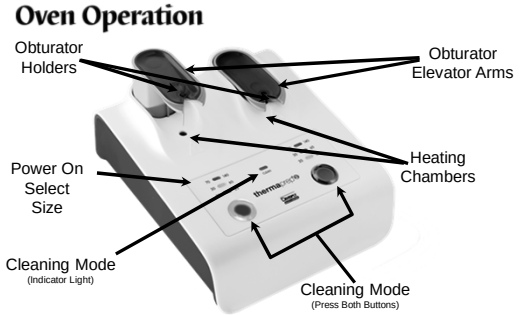
Oven Operation



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Oven Operation

- Push Holder Down to Begin Heating
- Listen for Beep
- Raise Holder
- Remove Obturator and Place in Canal

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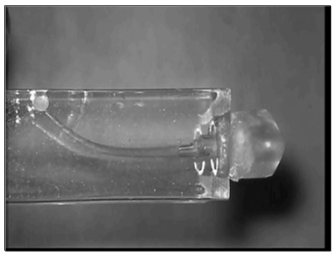
GuttaCore ™ : Placement



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GuttaCore: handle removal (Ronguer)

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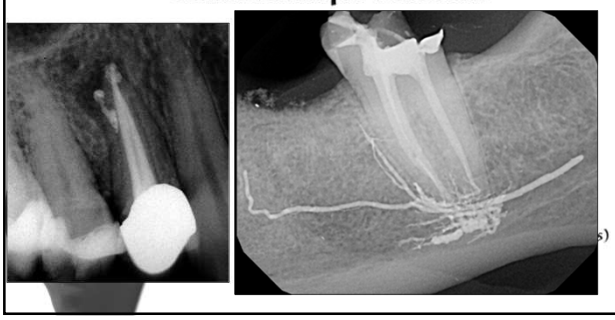
Clinical Technique -Placement



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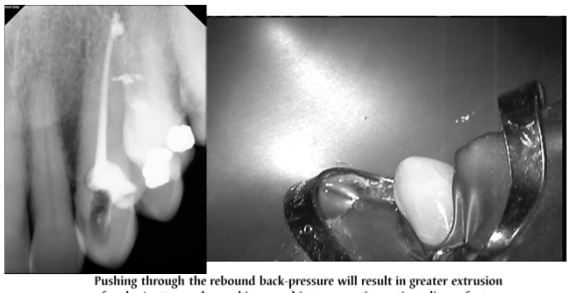
"Rebound Effect"



Pushing through the rebound back-pressure will result in greater extrusion of sealer/gutta percha, and increased intra-operative patient discomfort

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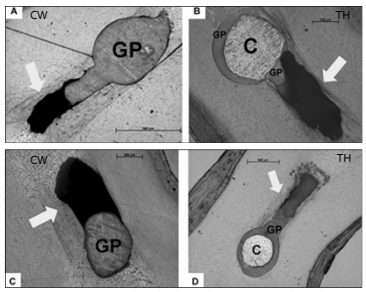

De-Deus G, Reis C, Beznos D, Gruetzmacher de Abranches AM, Coutinho-Filho T, Paciornik S: *Limited Ability of Three Commonly Used Thermoplasticized Gutta-Percha Techniques in Filling Oval-shaped Canals.* J Endod 2008;34:1401–1405

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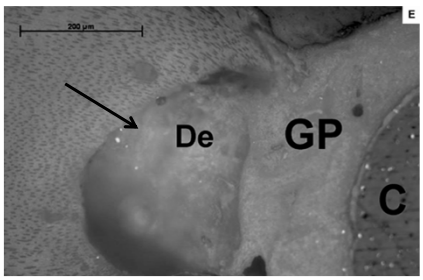

De-Deus G, Reis C, Beznos D, Gruetzmacher de Abranches AM, Coutinho-Filho T, Paciornik S: *Limited Ability of Three Commonly Used Thermoplasticized Gutta-Percha Techniques in Filling Oval-shaped Canals.* J Endod 2008;34:1401–1405

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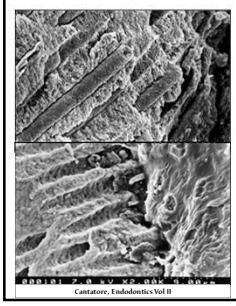
Clinical Technique - Shaping



- Fluid dynamics influenced by size/taper
  - ✓ Hagen-Poiseuille Law
- Fixed / Variable Taper ≥ .06
  - ✓ Less extrusion (Heeren 2012, Whitten 2015)
  - ✓ Centered carrier; uniform hydraulic forces (Neuhaus 2015)
- Irrigation/Smear layer removal
  - ✓ Improved flow characteristics
  - ✓ Enhanced adaptation/infiltration

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Clinical Technique – Size Verification

- Remove the GuttaCore™ size verifier from the obturator package
- Confirm working length and passive fit *in a wet canal*
- Rotate in the canal 360°
- Re-Irrigate the canal
- *Dry the canal* with a paper point prior to application of sealer

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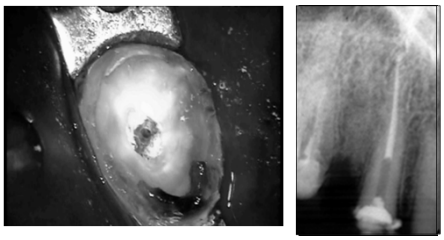
Post-Space Preparation



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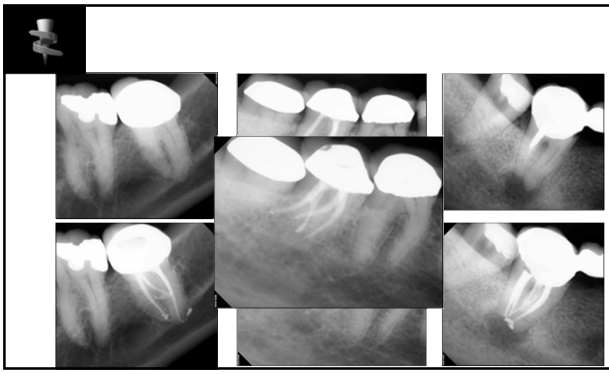

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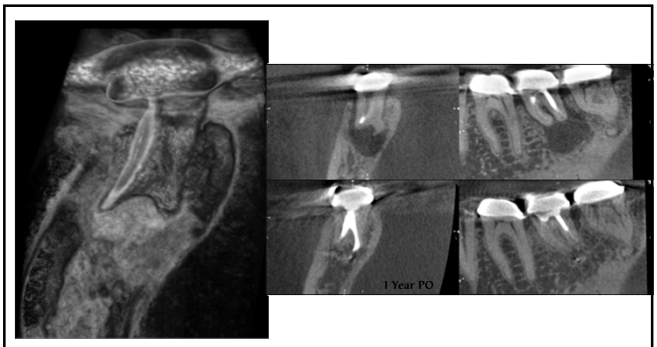

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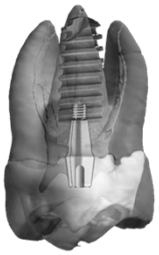

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