

INTRODUCTION TO ADVANCED ENDODONTICS A LABORATORY COURSE

This course will introduce you to the various techniques of access preparation, chemomechanical instrumentation and obturation of the root canal system. With this background you can make an intelligent decision in selecting the mode of treatment best suited for a particular clinical situation. This laboratory course will also provide a means for evaluating the resident's incoming level of proficiency in clinical endodontics.

Every effort is made to simulate actual clinical conditions. The resident will use a dental operatory to perform endodontic treatment on extracted teeth mounted in a mannequin head.

This course is divided into two sections. The first section is devoted to manual techniques and the second involves the introduction of NiTi rotary techniques, regenerative endo and other clinical procedures. The course is conducted during the summer term of the first year. In addition to the laboratory exercises, the Intro Course provides an overview of the foundation sciences for understanding the mechanisms and management of apical periodontitis.

OBJECTIVES

1. To recognize and create adequate straight-line access through the orifices into the canal system.
2. To become familiar with various techniques of chemomechanical instrumentation.
3. To become familiar with various techniques of root canal obturation.
4. To demonstrate the ability to understand and follow directions precisely.
5. To introduce you to the complexities of endodontic anatomy.
6. To practice intra-oral photography.
7. To generate your own instructional materials relating to endodontic access, chemomechanical instrumentation, obturation, and endodontic anatomy.
8. To become familiar with digital radiography and demonstrate adequate radiographic technique.
9. To learn and demonstrate the ability to document and present endodontic cases appropriately in digital case presentation style (which will be used throughout your residency).
10. To review the foundation sciences of endodontics including mechanisms and management of apical periodontitis.

REFERENCES

1. Department Video Tapes
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3. Pathways of the Pulp - 11th edition, Ken Hargreaves and Lou Berman, Mosby Co., 2016.
4. Endodontics - 4th edition, John Ingle & Leif Bakland, Williams & Wilkins, 1994.
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7. Endodontic Therapy - 4th edition, Frank Weine, Mosby Co., 1989.
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MATERIALS

1. Endodontic Kit
2. Endodontic mannequin with mounted extracted teeth
3. Teeth: The following are the minimum requirements for this course. It is recommended that you have extras, and it is highly desirable for you to experiment with "hybrid techniques" on additional teeth as time allows. The teeth should be stored in glycerin (diluted to 1/2 strength with water) or 10% formalin.

TOOTH	NUMBER REQUIRED		
	1st Section	2nd Section	Total
Maxillary Central Incisor	1	5	6
Maxillary Lateral Incisor			
Maxillary First Bicuspid (two roots)	1		1
Maxillary Second Bicuspid (one root)	1		1
Maxillary First or Second Molar	2	1	3
Maxillary or Mandibular Cuspid	1		1
Mandibular Incisor (Central or Lateral)	1	2	3
Mandibular Bicuspid (two roots)	1		1
Mandibular Cuspid			
Mandibular First or Second Molar	1	3	4
Typical TOTAL (minimum)			30*

*Actually fewer needed, some exercises allow choice of tooth type.

NOTE: After teeth are selected, they should be cleaned by soaking them in Clorox (full strength) for 20 minutes. Over-soaking will result in the formation of a white decalcified film on the root surfaces which will make photographing of the root sections less pleasing. The cementum and dentin will actually be damaged also.

Save all teeth that have separated files for Exercise V in Part II !

CASE PRESENTATION PROCEDURES

The course is divided into two sections and, at the end of each section, all of the cases will be presented to the class by digitally projecting the clinical photographs, radiographs, and dental operating microscope (DOM) photographs that you will do in PowerPoint presentations. This is a learning experience for all and most residents find that they learn more from cases that went awry. Thus, plan on presenting and discussing "the good, the bad, and the ugly". It is expected that details of each case be noted, and if procedures differed from the stated techniques, that you be able to explain and justify that deviation. Since these projects are to simulate clinical endodontic procedures, procedural accidents should be handled as well as possible, and presented as such.

A portfolio of your cases should be placed on the Department server at the completion of the course (cfs\links\endo\projects\All_Public\GradEndo\IntroAdvEndo).

The digital documentation for each case should be created in the following sequence:

- Radiograph #1 - facial-lingual view (clinical)
- Radiograph #2 - mesio-distal view (proximal)
- Radiograph #3 - evaluation pre-op view(s) in mannequin
- Clinical Photograph #1 - Pre-access
- Clinical Photograph #2 - Access
- Radiograph #4 - first instrument(s) to working length
- Radiograph #5 - final instrument(s) (Master Apical File, "MAF")
- Clinical Photograph #3 - Modified access (if applicable)
- Clinical Photograph #4 - Orifices just before obturation (try to get all orifices at once)
- Radiograph #6 - master cone(s) fitted (Optional according to exercise)
- Radiograph #7 - condensation
- Radiograph #8 - post-op in mannequin
- Clinical Photograph #5 - Orifices just after obturation (try to get all orifices at once)
- Radiograph #9 - after treatment facial-lingual clinical view(s)
- Radiograph #10 - after treatment mesio-distal proximal view(s)
- DOM Photograph #1 - apex undisturbed
- DOM Photograph #2 - apex skimmed
- DOM Photograph #3 - first sign of filling material(s)

DOM Photograph #4 - 1 mm from apex

DOM Photograph #5 - 3 mm from apex

DOM Photograph #6 - 5 mm from apex

DOM Photograph #7 - 7 mm from apex

DOM Photograph #8 - 9 mm from apex

Additional DOM photographs are encouraged if interesting findings are found during your dissection of each root (e.g. multiple foramina, accessory canals, lateral canals, missed canals). **You should observe the root constantly during dissection rather than just dissect to certain mm locations and then photograph. You will miss interesting anatomy and alterations created by your preparation procedures and obturation techniques.** Digital radiography is a routine part of the course. Computer projection of digital radiographic images is the norm as are digital dissection microscopic images. You will become familiar with Adobe Photoshop and PowerPoint presentation graphic programs as well as digital Xray software (MiPacs). The course grade will reflect performance during the seminar presentations as well as the case presentation documentation.

RADIOGRAPHIC PROCEDURES

Radiographs:

Ten (10) digital radiographs, (*see below*) are taken of each tooth. Place them in the appropriate digital exam format.

See previous page for description of required radiographic images.

During certain exercises the master cone fitted radiograph (#6) can be eliminated.

Radiographic Procedures:

A. **Before** mounting the teeth in the dentoform:

Radiograph #1 & 2: Take facial-lingual and mesio-distal views of each tooth.

Place a **small** piece of soft wax on the **crown** to hold the tooth in the proper position on the digital sensor (always double bag sensor with Schick bag and finger cot).

The exposure settings will vary from one radiographic unit to the next. Experiment with settings between 4 and 10 impulses. After this radiographic image is taken, attach soft wax at the apex(s) prior to mounting the teeth in the dentoform.

B. **After** mounting the teeth in the dentoform (**dentoforms have been modified for digital sensors**): The following radiographs are required:

Radiograph #3: Evaluation (Pre-Op) in mannequin

Radiograph #4: First instrument (premolars with 2 canals and mandibular molars require an additional film taken at 20 degrees from the mesial or distal).

Radiograph #5: Final instrument(s) (MAF)

Radiograph #6: Master cone(s) fitted (Tug-back). This radiograph may be omitted during some exercises.

Radiograph #7: Condensation (before temporary restoration placement and rubber dam removal)

Radiograph #8: Post-op (after rubber dam removal; tooth still in dentoform)

Radiograph #9 & 10: After the root canal treatment is completed, remove the tooth from the dentoform and repeat the two views of radiograph #1 & 2 (above) that were taken before the tooth was placed in the dentoform

CLINICAL PHOTOGRAPHS

Endodontic photography can place special demands on the camera setup. Because often we take photographs of single teeth or apices of teeth during surgery. On the other hand, full-face views are also required to document a case well. A variety of camera setups can be used. Ideally, images will be taken with a DOM (dental operating microscope).

Access preparation is an important step in being able to provide successful endodontic therapy. It can enhance or hinder the delivery of that treatment. A pre-access image is required as is an initial access image taken at the time of working length determination. An additional access image just before obturation should be taken if major revisions of the access were made to facilitate total canal preparation. This usually is the case. The pre-access, access, modified access, and the two orifice images should be taken in this course with the digital camera mounted on the dissecting microscope in the lab or on the SOM in the dental treatment room. Your clinical images will essentially be a "Carr" series originally proposed by Dr. Gary Carr of San Diego, California.

Case presentation is not complete without the photographic images that accompany the radiographic images.

SECTION ONE

The following exercises will expose the student to various techniques and filling materials. After obturation, immediately place each tooth in a small bottle containing a wet 2" x 2" gauze. The tooth number, by exercise, will be written on the cap. Cap the bottle tightly and place it in an incubator (Endodontic Dept. Laboratory, Rm. 4.518U) for at least 2 days. This will keep the tooth moist and prevent cracking while the root canal sealer is setting.

SELECT THE TEETH:

Remember, the following is required for documentation of each exercise:

- *Radiograph the teeth prior to mounting in the dentoform. Dentoform modification has been done for digital sensors.
- *Radiographs and photographs taken during the exercise.
- *Post treatment radiographs with tooth out of the dentoform.
- *Section and photograph under the dissecting microscope/SOM and photograph.
- *Prepare a separate PowerPoint file for each individual case for presentation.
- *Maintain the raw digital images and the photographic images in their JPEG format. Organize them by individual exercise.

Exercise I:

Tooth #1: Maxillary Central Incisor

Tooth #2: Mandibular Incisor

Instrumentation: Weine (Filing and Flare)

NOTE: No rotation of files (reaming action) is advocated.

Obturation: Lateral Condensation with gutta-percha and Roth Sealer

Reference: Weine; 4th ed. pages 285-308. (Anderson)

Weine FS, Kelly RF, Lio PJ. The effect of preparation procedures on original canal shape and on apical foramen shape. J Endod 1975;1:255-62.

(Alelyani)

Gutmann J, Lovdahl P. Problem Solving in Endodontics 2011: Mosby, chapter 8. Problem Solving In tooth isolation, access openings, and identification of orifice location. (all read)

Gutmann J, Lovdahl P. Problem Solving in Endodontics 2011: Mosby, chapter 10. Problem Solving Clinical Techniques in Enlarging and Shaping the root canal. (all read)

Gutmann J, Lovdahl P. Problem Solving in Endodontics 2011: Mosby, chapter 12. Problem Solving challenges in root canal obturation. (all read)

Additional Objective: Prior to instrumentation explore the canal system of the mandibular incisor with a #8 or #10 file in which you have placed an apical bend. Search for the lingual canal in the mandibular incisor. Clinically locate the foramen and the direction of exit. Does it correspond to your radiographic estimate of WL? Which should you believe?

Exercise II:

Tooth #3: Maxillary 1st Bicuspid (two roots)

Instrumentation: Ingle (Ream and File) - Quarter turn pull

Obturation: Halothane dip of gutta-percha ("Slam Dunk"). Either a standard or nonstandard gutta-percha cone is fit 2 mm short of WL. After placement of sealer the cone is dipped in halothane for 5-7 seconds (chloroform for 1-3 sec) and seated completely to WL. Do not remove the cone. Use lateral condensation.

Reference: Ingle 2nd ed., pages 192-205 and Ingle 4th ed., pages 264-6. (Hawkins)

Wong M, Peters DD, Lorton L. Comparison of gutta-percha filling techniques: compaction (mechanical), vertical (warm) and lateral condensation techniques, part 1. J Endod 1981;7:551-8. (Sandhu)

Wong M, Peters DD, Lorton L, Bernier WE. Comparison of gutta-percha filling techniques: three chloroform - gutta-percha filling techniques, part 2. J Endod 1982;8:4-9. (Wong)

Allison DA, Michelich RJ, Walton RE. The influence of master cone adaptation on the quality of the apical seal. J Endod 1981;7:61-5. (AlMalwi)

Holcomb JQ, Pitts DL, Nicholls JI. Further investigation of spreader loads required to cause vertical root fracture during lateral condensation. J Endod 1987;13:277-84. (Anderson)

Stropko JJ. Canal morphology of maxillary molars: clinical observations of canal configurations. J Endod 1999;25(6):446-450. (all read)

Additional Objective: Explore the canal system. Introduction to chemically softened use of gutta-percha obturation. How much condensation pressure do you generally use during lateral condensation? What is the recommended spreader load? Was less required, to achieve adequate spreader depth? Did the "Champagne Bubble Test" help you find canal orifices? What would lead to a false positive or false negative result from the "Champagne Bubble Test"

Exercise III:

Tooth #4: Maxillary or mandibular cuspid

Instrumentation: Schilder filing and flaring. Instrumentation must allow penetration of the initial Schilder condensation instrument to within 3-5 mm of the apex

Obturation: Warm Vertical Condensation of gutta-percha with sealer.

NOTE: Use your Schilder instruments from your kit. Touch N' Heat or a System B can be used to melt the gutta-percha.

Reference:

Pathways of the Pulp 11th ed. Chapters 12, 13, 14, 15 (all read)

Schilder H. Cleaning and shaping the root canal. Dent Clin North Am 1974;18: 269-96. (Alelyani)

Schilder H. Filling root canals in three dimensions. Dent Clin North Am 1967; Nov:723-44. (Hawkins)

Additional Objective: Tapering preparations and access requirements. Concept of "Three Dimensional Obturation."

Exercise IV:

Tooth #5: Maxillary Molar - (the tooth selected should have an apical or mid-root curvature and be moderately calcified)

Instrumentation: Roane "Balanced Force" technique. Use Gates Glidden burs to the curve (#2 apically to #4 at orifice) to preflare the canal. Reestablish an apical control zone to a minimum size #40 or #45 after enlargement at the radiographic canal length.

Obturation: MB & DB canals - Thermafiles with sealer

Palatal canal - Lateral Condensation with gutta-percha using Chloroform or halothane dip technique described in Exercise II.

Reference: Roane JB, Sabala CL, Duncanson MG. The "Balanced Force" concept for instrumentation of curved canals. J Endod 1985;11:203-11. (Sandhu)

Southard DW, Oswald RJ, Natkin E. Instrumentation of curved molar root canals with the Roane technique. J Endod 1987;13:479-89. (Wong)

Gutmann J, Lovdahl P. Problem Solving in Endodontics 2011: Mosby, chapter 13. Problem Solving challenges in compromised roots, root canal systems and anatomic deviations. (all read)

Krasner P, Rankow H. Anatomy of the Pulp-Chamber floor. J Endod 30:5, 2004 (all read)

Thermafil Video tape

Additional Objective: To introduce the student to the use of Gates-Glidden drills within the canal as a means of preflaring. To understand the concept of the "apical control zone." To search for the fourth (MB2) orifice. **SAVE THIS TOOTH FOR EXERCISE XI of PART II !**

Exercise V:

Tooth #6: Mandibular 1st Molar

Instrumentation: Mandibular Molar - Balanced Force

MB - Ingle Quarter Turn and Pull with Stepback. Use anticurvature flaring.

ML - Balanced Force

Distal - Schilder Filing and Flaring as in Exercise III

Obturation: Mandibular Molar-

MB canal - Lateral Condensation of gutta-percha with sealer

ML canal - Halothane softened gutta-percha with lateral condensation and sealer

D canal - Obtura

Reference: Obtura Videotape

Abou-Rass M, Frank AL, Glick D. The anticurvature filing method to prepare the curved root canal. J Am Dent Assoc 1980;101:792-4. (AlMalwi)

Leeb J. Canal orifice enlargement as related to biomechanical preparation. J Endod 1983;9:463-70. (Anderson)

Abou-Rass M, Jastrab RJ. The use of rotary instruments as auxiliary aids to root canal preparation of molars. J Endod 1982;8:78-82 (Hawkins)

Montgomery S. Root canal wall thickness of mandibular molars after bio-mechanical preparation. J Endod 1985;11:257-63. (Alelyani)

Additional Objective: To understand the concept of "anticurvature filing." Note the mesial canal preparations. Which technique of canal preparation demonstrated the most transportation. To introduce injectable GP techniques and condensation.

Exercise VI:

Tooth #7: Maxillary 2nd Premolar

Instrumentation: Ultrasonic instrumentation with Analytic, Amadent P5 or Spartan units

Obturation: Chloroform or Halothane dipped lateral condensation

Reference: Ingle 4th ed. pp 175-9. (Sandhu)

Martin H, Cunningham W. Endosonics--the ultrasonic synergistic system of endodontics. Endod Dent Traumatol 1985;1:201-6. (All read)

Additional Objective: To introduce the student to the use of ultrasonic means of canal preparation

Exercise VII:

Tooth #8: Mandibular Bicuspid (two canals)

Instrumentation: Prepare the more difficult canal with quarter turn and pull with minimal flare and use more of a Balanced Force technique on the easier one. Concentrate on early preflaring to the point at which the canals bifurcate.

Obturation: Use techniques that maximize the GP flow, either Chemical Dip or Warm vertical.

Reference:

Goerig A, Michelich R, Schulz, H. J Endod 1982;8:550-4 (All read).

Pathways of the Pulp 11th ed., Chaps 5 (All read)

Additional Objective: To become familiar with the anatomy of bifurcated mandibular bicuspids and how this anatomy affects canal system preparation and obturation.

Exercise VIII:

Tooth #9: Maxillary 1st Molar

Instrumentation: MB - File & Ream. Concentrate on maintaining a standard .02 taper as much as possible.

DB - Weine Filing and Flare. Gates-Glidden burs or Peeso reamers may be used at the orifice only. Provide a standard .02 taper to the canal.

Palatal Canal - Ingle Quarter turn pull with flaring.

Obturation: MB & DB - silver cones coated with AH26 as the sealer. Let a faculty member check the fit of the silver cone prior to cementation. Place a notch on the silver points 2mm coronal to the canal orifice and twist off the silver points after obturation (this will give a 2mm "handle" to focus your efforts during the subsequent re-treatment exercise).

Palatal canal - Thermafil. Use AH-26 sealer in all canals

Close the access with an Amalgam restoration (NO base). The silver points are often difficult to distinguish from amalgam during retreatment exercises and therefore this represents a good simulation of the clinical silver point retreatment case. Save this tooth for the next exercise!

Reference: Weine; 4th ed., pages 308-338. (Wong)

Weine; 4th ed., pages 416-430 (AlMalwi)

Ingle; 3rd ed., pages 255-258. (Anderson)

Pathways of the Pulp 11th ed., Chap 7 (All read)

Additional Objective: Using silver cones is now considered obsolete. Historically it had been advocated in fine curved canals. The technique of canal preparation may contribute to selection of obturation material and technique. Silver cone preparations were classically taught as a machined round minimally tapered preparation. With latex allergy increasingly common, what other alternative materials could be used?

Exercise IX:

Tooth #10: Maxillary 1st Molar used in Exercise VIII.

Retreatment: Trade teeth with one of the other residents so that you will not be retreating the same tooth you previously filled. Assume that this silver cone treatment was initially performed 10 years ago and is clinically successful. For Prosthetic reasons you are asked to retreat the case before the tooth is to be restored with a post retained crown.

Instrumentation: Modify the access preparation as necessary to retrieve the silver cones. Retrieve the silver cones and Thermafil device (if possible) by any means clinically possible. Retreat each of the canals with a different method of instrumentation using the canal and root anatomy as the deciding factor.

Obturation: Use a different method of obturation in each canal based on what technique you think is most appropriate for the preparation design but include at least 1 canal obturated with a warm vertical compaction using .04 GP cones.

Reference: Pathways of the Pulp; 11th ed., Chap 8 (Re-Tx) **(All Read)**

Gutmann J, Lovdahl P. Problem Solving in Endodontics 2011 Chap 14. **(All Read)**

Additional Objective: Think about what your discussion with the patient prior to retreatment should involve. Possible alternatives, risks, benefits, etc.

THIS COMPLETES THE FIRST SECTION EXERCISES !!

SECTION TWO

OBJECTIVE

To become acquainted with and gain proficiency in rotary techniques of root canal preparation.

We will practice each rotary system on a plastic block before we try it in any of the teeth!

Exercise I:

Tooth #1: Maxillary Central Incisor

Tooth #2: Mandibular Incisor or Maxillary Canine or Single Canal Bicuspid

Instrumentation: LightSpeed System. Prepare canal according to LightSpeed directions

Obturation: Obturate one tooth with warm vertical condensation. Obturate one tooth with SimpliFill (optional). Pick a tooth which you have been able to prepare parallel with little or no taper in the apical 4-5 mm if you decide to use SimpliFill.

Reference: LightSpeed Video Tapes. **(ALL)**

Card SJ, Sigurdsson A, Orstavik D, Trope M. The effectiveness of increased apical enlargement in reducing intracanal bacteria. J Endod 2002;28:779-83;
(Alelyani)

Shuping G, Orstavik D, Sigurdsson A, Trope M. J Endod 26:751, 2000.
(Hawkins)

Pathways of the Pulp - 11th edition Chap 3 **(all read)**

Additional Objective: The use of a completely rotary method of canal preparation will never completely replace the need for hand instruments. A well-trained endodontist needs these skills and understanding of the applications of nickel-titanium instruments. To evaluate different canal preparation shapes and their relationship to different obturation techniques.

Exercise II:

Tooth #3: Maxillary Central Incisor, and

Tooth #4: Mandibular Incisor or Maxillary Canine or Single Canal Bicuspid

Instrumentation: ProFile System. Prepare canal crowdown according to ProFile directions.

Obturation: Obturate one of the teeth with ProRoot MTA using the Lawaty technique as described by Bogen and Kuttler (2009). As an alternative to the Lawaty method, use a pre-fitted gutta percha cone and "tamp down" the MTA in the other tooth. As you back-fill with MTA, cut off sections of the GP cone so that its diameter corresponds with the diameter of the root canal system where you are tamping down the MTA. What were the advantages and disadvantages of each approach? Which one did you prefer? Obturate the second tooth with BioDentin using either the Lawaty or GP cone method. Do you prefer working with ProRoot MTA or BioDentin? Why? (Please contact Ms Sanda Sierra to obtain the MTA and BioDentin).

Reference: ProFile Video Tapes (ALL)

Gani O, Visvisian C. Apical canal diameter in the first upper molar at various ages. J Endod 1999;25:689-91. (Sandhu)

Bogen G, Kuttler S. Mineral Trioxide Aggregate Obturation: a review and case series. J Endod 35:777-90, 2009. (all read)

Additional Objective: The use of a completely rotary method of canal preparation will never completely replace the need for hand instruments. A well-trained endodontist needs these skills and understanding of the applications of nickel-titanium instruments. To evaluate different canal preparation shapes and their relationship to different obturation techniques.

Exercise III:

Tooth #5: Maxillary incisor (MTA Apexification)

Instrumentation: The primary purpose of this assignment is to learn MTA apexification for the immature permanent tooth with incomplete root development. First, instrument the canal system up to an .06 tapered rotary NiTi file of your choice to a MAF of 40, then prepare a blunderbuss open apex using the method described by Hachmeister and colleagues. Inject Ca(OH)₂ paste (UltraCal™) the entire length of the root canal system using a Max-i-Probe 30g needle. Take a radiograph of the paste treatment. Remove the paste by irrigating with 6% NaOCl and then obturate.

Obturation: Adapt a small piece of CollaPlug at apex, perform MTA apexification with indirect ultrasonic condensation and verify position and density of MTA by a radiograph. Complete obturation with internal bonding with composite (Build-It™, Pentron Inc) using the method described by Witherspoon and colleagues.

Additional Objective: To become familiar with MTA apexification and internal bonding with a dual cured composite.

References: Hachmeiser D, Schindler W, Walker W, Thomas D. The sealing ability of mineral trioxide aggregate in a model of apexification. J Endod 28:686-90, 2002. (Wong)

Witherspoon D, Small J, Regan J, Nunn M. Retrospective analysis of open apex teeth obturated with MTA. J Endod 34:1171-6, 2008. (all read)

Exercise IV:

Teeth #6-7: Maxillary incisor (Regendo)

Instrumentation: The primary purpose of this assignment is to learn regenerative endodontic treatment for the immature permanent tooth with incomplete root development. First, instrument the teeth up to an .06 tapered rotary NiTi file of your choice to a MAF of 40, then prepare a blunderbuss open apex using the method described by Hachmeister and colleagues. There is no-to-minimal instrumentation for regenerative procedures. Instead, slowly irrigate the root canal system with 1.5% NaOCl. Note the potential for exposure of NaOCl to the periapical tissue. Be prepared to discuss why NaOCl irrigation is associated with minimal patient complaints of pain under these conditions. What is different under these conditions compared to an NaOCl accident?

Obturation: Tooth #6: Mix up triple antibiotic paste (TAP) (ciprofloxacin:metronidazole:minocycline) with sterile water (creamy consistency is ~500-1000mg/ml) and inject into root canal system using a Centrix™ syringe. Take a photo of the root and crown before placing TAP, after placing TAP to the CEJ and 2 days after placing TAP all the way to the access opening. The use of TAP in clinical procedures of regenerative endodontics has been described by Banchs and Trope 2004, Hargreaves et al., 2008 and Jung et al., 2008. Remove TAP by irrigation with 17% EDTA, and place a Colla-Plug 3mm apical to the CEJ (this will cover the blood in clinical cases). Place 3mm MTA with indirect ultrasonic condensation from the Colla-Plug to the CEJ. Seal access with Z100 composite. See mpeg movie by Drs. Shiloah and Lovelace.

Tooth #7: Treat as tooth #6, but stop after placing the MTA. Incubate the access opening with TAP for 3 days and take before and after photographs. What color changes are noticed? What causes this staining? Remove the stain by the "walking bleach" (sodium perborate paste mixed with water) method as described by Rotstein et al. (1993) and seal the access with Cavit. Take photographs at 1, 3 and 7 days. If needed, repeat with a second treatment. The place DAP (metronidazole:ciprofloxacin) into the coronal pulp chamber and repeat photographs at 1, 3 and 7 days. Is there a difference? Why?

Additional
Objective:

To become familiar with placement and potential staining of triple antibiotic paste in regenerative endodontic procedures. Note that provoking bleeding into the root canal system is a critical clinical step in this procedure. Recent studies indicate that anesthesia with a vasoconstrictor containing local anesthetic often leads to reduced bleeding potential. Remember to consider the use of 3% mepivacaine without vasoconstrictor when performing the bleeding step on your patients. Why would the second appointment use 17% EDTA instead of NaOCl? What are the advantages/disadvantages to this sequence?

References:

Banchs F, Trope M. Revascularization of immature permanent tooth with apical periodontitis: new treatment protocol? J Endod 30:196, 2004. **(all read)**

Jung I, Lee S-J, Hargreaves K. Biologically based treatment of immature permanent teeth with pulpal necrosis: A case Series. J Endod 34:876, 2008. **(all read)**

Bose R, Nummikoski P, Hargreaves K. A retrospective evaluation of radiographic outcomes in immature teeth with necrotic root canal systems treated with regenerative endodontic procedures. J Endod 35:1343, 2009. **(all read)**

Diogenes & Company. Regenerative Endodontics. Pathways of the Pulp, 11th edition (Chap 10), 2016. **(all read)**

Murray PE, Garcia-Godoy F, Hargreaves KM. Regenerative endodontics: a review of current status and a call for action. J Endod 2007;33(4):377-390. **(AlMalwi)**

Lovelace TW, Henry MA, Hargreaves KM, Diogenes A. Evaluation of the delivery of mesenchymal stem cells into the root canal space of necrotic immature teeth after clinical regenerative endodontic procedure. J Endod 2011;37(2):133-138. **(Anderson)**

Exercise V:

Teeth #8-10: Select three teeth that have had separated files from previous exercises (or see Dr. Hargreaves who can help you generate teeth for this exercise...).

Instrumentation: Depends on circumstances; ideally, use teeth with separated files of .04 taper or larger. Prepare a centering platform as described by Iqbal et al., 2006. Remove one file using the method described by Eleazer and O'Connor 1999. Remove one file each using the Masseran and ultrasonic filing methods described by Terauchi et al 2007.

Obturation: System B

Additional Objective: To become familiar with different methods of retrieving or bypassing separated instruments

Reference: Iqbal M, Rafailov H, Kratchman S, Karabucak B. A comparison of three methods for preparing centering platforms around separated instruments in curved canals. J Endod 32:48-51, 2006. **(Alelyani)**

Eleazer P, O'Connor R. Innovative uses for hypodermic needles in endodontics. J Endod 25:190-1, 1999. **(Hawkins)**

Suter B. A new method for retrieving silver points and separated instruments from root canals. J Endod 24:446-8, 1998. **(Sandhu)**

Terauchi Y, O'Leary L, Kikuchi I, Asanagi M, Yoshioka T, Kobayashi C, Suda H. Evaluation of the efficiency of a new file removal system in comparison with two conventional systems. J Endod 33:585-8, 2007. **(Wong)**

Ruddle C. Nonsurgical retreatment. J Endod 30:827-45, 2004. **(all read)**

Re-review on your own: Pathways 11th: Chap 8 and Gutmann Chap 9. **(no abstract)**

Exercise VI:

Tooth #11: Maxillary or Mandibular 1st Molar

Instrumentation: Protaper instrumentation only (to file F3 or F4)

Obturation: **Do not obturate this tooth at this point**

Reference: Lemon R. Nonsurgical repair of perforation defects. Dent Clin North Am 1992;36:439-57. (AIMalwi)

Pace R, Giuliani V, Pagavino G. Mineral trioxide aggregate as repair material for furcal perforation: case series. J Endod 2008;34(9):1130-1133.

Mente J, Hage N, Pfefferle T, Koch MJ, Geletneky B, Dreyhaupt J, et al. Treatment outcome of mineral trioxide aggregate: repair of root perforations. J Endod 2010;36(2):208-213.

Additional Objective: To perform an internal repair of a strip perforation within the root canal system using ultrasonically placed MTA and Biodentin, followed by gutta-percha obturation using warm vertical compaction. Place make a perforation in two of the root canal systems. If you need assistance, Dr. Hargreaves will "visit" with your patient after instrumentation, creating two procedural error s(Strip perforation) that you will repair.

Additional Objective: How do you like working with ProRoot MTA versus BioDentin? Why are they classified as calcium silicate cements? Self examination and evaluation of the technique you have gravitated towards.

Exercise VII:

Tooth #12: Maxillary or Mandibular 1st Molar

Instrumentation: Protaper (SX to F1) followed by apical preparation with Profiles (size 25-30-35-40) or K3 (size 25-30-35 or40) instruments

Obturation: MB and DB Canals (MB or ML in Mand) with vertical condensation. P (or D) canal with lateral condensation.

Reference: <https://www.youtube.com/watch?v=LXzzNFJ5cck><https://www.youtube.com/watch?v=OAxMEcz-Aw>

Additional Objective: Remember the concept of maintaining curves and yet providing adequate coronal flare.

Exercise VIII:

Tooth #13: Mandibular or Maxillary 1st Molar

Instrumentation: Protaper (SX to F1) followed by apical preparation with Profiles (size 25-30-35-40) or K3 (size 25-30-35-40) instruments

Obturation: Warm vertical compaction; then prepare the distal canal to receive a cemented, parallel-sided prefabricated post. Cement the post with a resin-based luting agent, then trade models with your fellow residents and remove their post using ultrasonic instrumentation.

Reference: <https://www.youtube.com/watch?v=LXzzNFJ5cck><https://www.youtube.com/watch?v=0AxxMEcz-Aw>

Hulsmann M. Methods for removing metal obstructions from the root canal. Endod Dent Traumatol 1993;9:223-37.

Additional Objective: To experience hybrid preparation techniques utilizing two major rotary instrument systems. To gain experience in permanent post removal with ultrasonic instrumentation.

Exercise IX:

Tooth #16: Use the maxillary molar from Exercise IV of Part I.

Instrumentation: This is a re-treatment exercise to remove the two Thermafil carriers and the GP in this previously obturated tooth. Remove one Thermafil carrier using the solvent/hand file method described by Bertrand et al., and the rotary file method described by Royzenblat et al. Remove the GP in the palatal system using heat. Re-instrument the three systems using the method of your choice.

Obturation: Wave of condensation using the System B and Obtura backfill.

Additional Compare two methods for removal of Thermafill carriers.

Objective:

References: Bertrand M, Pellegrino J, Rocca J, Klinghofer A, Bolla M. Removal of Thermafil root canal filling material. J Endod 23:54-7, 1997. **(Anderson)**

Royzenblat A, Goodell G. Comparison of removal times of Thermafil plastic obturators using ProFile rotary instruments at different rotational speeds in moderately curved canals. J Endod 33:256-8, 2007. **(Alelyani)**

Make sure your digital documentation is complete and organized so that all raw images and PowerPoint presentations are ready to copy to a CD.

THIS COMPLETES THE SECOND SECTION EXERCISES !!

DENTAL OPERATING MICROSCOPE (DOM) PROCEDURES

After obturation, the teeth are sectioned prior to being examined, and photographed using a dOM. For best results use a dark blue or dark green rubber dam background when photographing the specimens. The rubber dam can be punched and the apex or root section isolated through the punched hole. Also because of the dust generated during shaving of the root, it is desirable to place the rubber dam in position only for the photograph. Dissecting procedures will be performed under the hood in the endodontic lab or *in the dental treatment room with the high volume evacuator adjacent to the tooth.*

Using a non-crosscut fissure bur for the dissections will leave a smoother surface across the cut surface, and improve the esthetics of the photograph. You will discover that moving the bur in one particular direction will disturb the GP less than in the other direction. Just prior to the photograph make sure the GP surface is smooth and not rippled. **Shave the root surface gradually while viewing it under the microscope.** You never know what aberrations in canal morphology or inconsistencies in the endodontic procedures will be seen. **Make sure the photographic quality is excellent before proceeding with the dissection. You can never go back! Focus is critical as is proper lighting.**

Compare the results from the different instrumentation and obturation techniques and then use this information to make intelligent decisions about your own method of treatment. **Since we will present cases throughout the course, you should perform dissections as you finish the exercises rather than waiting until you have done all the exercises before dissecting. Doing it this way will magnify your learning experience.**

NOTE: Mark the mm's on the side of the root with a pencil or fine Sharpie. Identify the exercise # and root as well as the root surface you marked for future reference (e.g., B or L). Orientation becomes confusing during presentation unless you know the orientation of the root.

MAGNIFICATION

Use the largest single magnification that includes the entire cut root surface. Orient the root with the widest dimension horizontal to coincide with the widest dimension of the film plane. Do not attempt to image more than one root of molar teeth in a single frame. Interesting findings should be enlarged and imaged separately.

VIEW (sectioned teeth), One Root at a Time!!

- Image #1 - Apex undisturbed (Focus on the Foramen)
- Image #2 - Apex skimmed*
- Image #3 - First sign of filling material(s)*

- Image #4 - 1 mm from the Apex
- Image #5 - 3 mm from the Apex
- Image #6 - 5 mm from the Apex
- Image #7 - 7 mm from the Apex
- Image #8 - 9 mm from the Apex

Interesting findings at other distances from the apex should also be photographed.

*May coincide

USING THE DOM

Faculty will demonstrate the procedure to you. You will gain experience in digital radiography, Adobe Photoshop, and MS PowerPoint programs. We will also use the DOMs in the treatment rooms with Nikon Coolpix cameras on the digital adaptors.

**DIGITAL
MICROSCOPIC CAMERAS**

We will demonstrate how to use your Canon or Sony camera to acquire images from the operating microscope.

**INTRODUCTION TO ADVANCED ENDODONTICS
PRECLINICAL COURSE**

IMAGE DOCUMENTATION

Exercise Number: _____

Instrumentation Techniques: _____

Obturation Techniques: _____

Image	TOOTH#	ROOT	LEVEL / VIEW	MAG
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
6	_____	_____	_____
7	_____	_____	_____
8	_____	_____	_____
9	_____	_____	_____
10	_____	_____	_____
11	_____	_____	_____
12	_____	_____	_____
13	_____	_____	_____
14	_____	_____	_____
15	_____	_____	_____
16	_____	_____	_____
17	_____	_____	_____
18	_____	_____	_____
19	_____	_____	_____
20	_____	_____	_____
21	_____	_____	_____
22	_____	_____	_____
23	_____	_____	_____

