INTRODUCTION TO ADVANCED ENDODONTICS A LABORATORY COURSE

Course Name & Number: Introduction to Advanced Endodontics, ENDO 5020

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Course Description and Overall Goals:

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 includes manual techniques, 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 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 be introduced 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.

11. To learn proper placement of fiber posts and coronal restorations in endodontically treated teeth.

Seminars

Seminar 1 Biology of Apical Periodontitis, Basics of Endodontics and Balanced force technique

- Seminar 2 Retreatment and management of teeth with fiber posts
- Seminar 3 Bioceramics in endodontics
- Seminar 4 Management of Strip Perforations
- Seminar 5 MTA obturation, Apexification and Regenerative Endodontics
- Seminar 6 Management of teeth with separated instruments

References

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- 3. Endodontics 4th edition, John Ingle & Leif Bakland, Williams & Wilkins, 1994.
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- 10. Gutmann J, Lovdahl P. Problem Solving in Endodontics 2011: Mosby, chapter 10. Problem Solving Clinical Techniques in Enlarging and Shaping the root canal.
- 11. Gutmann J, Lovdahl P. Problem Solving in Endodontics 2011: Mosby, chapter 12. Problem Solving challenges in root canal obturation.

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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 Types	Number required
Maxillary Central or Lateral Incisor	4
Maxillary First Bicuspid (two roots)	1
Maxillary First or Second Molar	2-5
Mandibular Incisor (Central or Lateral)	2
Mandibular First or Second Molar	1-5

NOTE: After teeth are selected, all teeth need to be autoclaved prior to use. For teeth with amalgam restorations, soak them in NaOCl (full strength) for 10 minutes and then remove all the amalgam prior to autoclaving. 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

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 Resident SharePoint site at the completion of the course Resident OneNote

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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) You will section and photograph the root cross section of all teeth, unless instructed not do it. Make sure you pay attention to the exercises that do should not be sectioned. The teeth will be used in the section 2 of the intro course. The cross section photographs should be as follows: 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 X-ray 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 in a power point presentation.

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.

Case presentation is **<u>not complete</u>** without the photographic images that accompany the radiographic images.

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. 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 lab

Lab I: Balanced force technique

Exercise #1:	Maxillary first bicuspid with two roots
	Instrumentation: Roane "Balanced Force" technique
	Obturation: Lateral Condensation with gutta-percha and Roth Sealer. Place a fiber post in the Buccal canal
Additional	How much condensation pressure do you need with this technique of
Objectives:	obturation? Were the canals centered? Where is the highest risk of a strip
5	perforation in this tooth type? How do you avoid it?
Exercise #2:	Max 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.
	Obturation: MB & DB canals – Thermafil with sealer; Palatal canal - Lateral
	Condensation with gutta-percha using Chloroform dip technique
	Did the "Champagne Bubble test" help you find the canals. What would lead to a false positive or false negative result with this test? Where was MB2 located?
	Restore the accesses in both teeth with composite. Do not place a cotton pellet or sponge in the access cavity. DO NOT SECTION THESE TEETH. SAVE FOR LAB 2

Reference:	Krasner P, Rankow H. Anatomy of the Pulp-Chamber floor. J Endod 30:5,
	2004
	Roane JB, Sabala CL, Duncanson MG. The "Balanced Force" concept for
	instrumentation of curved canals. J Endod 1985; 11:203-11.
	Southard DW, Oswald RJ, Natkin E. Instrumentation of curved molar root
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	chapter 13. Problem Solving challenges in compromised roots, root
	canal systems and anatomic deviations.
	Schwartz, R and Robbins, W. Post Placement and Restoration of
	Endodontically Treated Teeth: A Literature Review. J Endodon 2004
	Pathways of the Pulp Chapter 8

Lab III	
1 st or 2 nd Molars	
Exercise# 1:	Use a bioceramic sealer with gutta percha to obturate using Warm Vertical technique
Exercise# 2:	Use a bioceramic sealer with gutta percha to obturate using the Hydraulic technique
Exercise# 3:	Use a bioceramic sealer with gutta percha to obturate using the hydraulic technique but
	place the gutta percha cone so it is 3mm short of working length in all 3 canals (the apical
	3mm of the WL should be obturated with bioceramic alone)
	Do not section the tooth from Exercise 3. Allow the bioceramic to set for 24 hours and
	Exchange with a fellow resident for Lab III
References	Endo on Demand: Annual meeting 2022 Lecture by Dr Jenny He

<u>Lab III:</u> Retreatment and management of teeth with fiber posts Use teeth from Lab 1 and II

Exercise #1:	Access must be made with diamond burs conservatively but sufficient to visualize
(Premolar)	the outline of the fiber post. Then using a Munce bur or Largo bur of appropriate
	size, drill through the post (coring it out) while maintaining proper angulation and
	working length to prevent procedural errors. Once gutta percha is reached, use
	Hedstrom files with chloroform to remove the apical GP. Then clean and shape the
	canals with whatever choice of rotary instrumentation you chose.
	Obturation: Warm Vertical condensation.
Exercise #2 (Max	Remove one Thermafil carrier using the solvent/hand file method described by
Molar)	Bertrand et al., and the rotary file method described by Royzenblat et al. Remove
	the GP in the palatal system using heat. Reinstrument using Edge Endo files
	Obturation: Wave of condensation using the System B and Obtura backfill
Exercise #3	Retreat the tooth from Lab II exercise #3 which was obturated with GP and a
	bioceramic sealer. Use handfiles and/or rotaries
	Obturation:Using any method of your choice
Additional Objectives:	How do the 2 techniques of removing Thermafil carriers compare?
	How did you remove the bioceramic sealer form the apical third

Reference:

Gesi et al. Comparison of two techniques for removing fiber posts. J Endod 2003

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

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

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Lab IV: Management of Strip Perforations

Exercises 1 & 2 Maxillary & Mandibular Molars (1 each). Select teeth with some degree of calcification	Instrumentation: Protraper instrumentations SX to F1 followed by Profile, K3 or Vortex blue (up to size 40) In the MB canal use only Protaper up to F3 or F4 to create a strip perforation. If a strip perforation is not created in one of the canals, ask a faculty member to help create one
	Use ultrasonically placed MTA to seal the perforation and obturate all canals with gutta percha and sealer
References:	Lemon R, Nonsurgical repair of perforation defects. Dent Clin North Am. 1992:36:43957
	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.
	Pathways of the Pulp- Managing Iatrogenic Events Chapter 20 Pathways of the Pulp
	https://www.youtube.com/watch?v=LXzzNFJ5cck

Lab V: MTA obturation, Apexification and Regenerative Endodontics

Exercise 1

MTA Obturation- 2 Maxillary or mandibular central incisors
Instrumentation: Profile or Protaper followed by lightspeed
Obturation: Obturate one of the teeth with 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? (If commercially available MTA is not available use Portland cement. The cement should be mixed with BaSO4 to 80:20 ratio of MTA:BaSO4 by weight.)

Exercise 2:	Apexification. Maxillary Incisor
	Instrumentation: The primary purpose of this assignment is to learn MTA
	First instrument the canal system up to an 06 tapered rotary NiTil 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 TM) 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
	Complete obturation with internal bonding with composite (BuildIt TM , Pentron Inc) using the method described by Witherspoon and colleagues
Additional	To become familiar with internal bonding with a dual cured composite
Objectives	Descentive en la douties Maxillany incient
Exercise 5:	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 NiTil 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%
	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: 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 ^{IM} syringe. Take a photo of the root and crown before placing TAP after placing TAP at the CEL and 2 days often 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 CollaPlug to the CEJ. Seal
	access with Z100 composite. See mpeg movie by Drs. Shiloah and Lovelace.
Reference	Bogen G, Kuttler S. Mineral Trioxide Aggregate obturation: a review and case series. J Endod 35:777-90, 2009.
	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
	Witherspoon D. Small J. Regan J. Nunn M. Retrospective analysis of open apex teeth
	obturated with MTA. J Endod 34:1171-6, 2008.
	Banchs F, Trope M. Revascularization of immature permanent tooth with apical
	periodontitis: new treatment protocol? J Endod 30:196, 2004.

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.

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.

Regenerative Endodontics. Pathways of the Pulp, Regenerative Endodontics 12th edition (Chap 12). 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.

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.

Lab VI: Management of teeth with separated instruments

Teeth #1-3:	Select three teeth that have had separated files from previous exercises (or see a faculty 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.

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

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

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.

Ruddle C. Nonsurgical retreatment. J Endod 30:827-45, 2004.

Re-review on your own: Pathways: Chap 8 and Gutmann Chap 9.

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

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

<u>Use the largest single magnification that includes the entire cut root surface.</u> 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. <u>Interesting findings should be enlarged and imaged separately.</u>

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

Image #1 - Apex undisturbed (Focus on the Foramen) - Apex skimmed* Image #2 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 Canon or Sony digital cameras.

DIGITAL MICROSCOPIC CAMERAS

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