

Endodontic Competency

Introduction

The American Association of Endodontists developed the following white paper to outline and define the requisite skills required by **all dentists** who perform endodontic diagnosis and treatment. These guidelines are meant to create a context for knowledge and skill that should provide a standard for all practitioners who undertake the responsibility to diagnose, treatment plan and provide prognoses for the endodontic care of their patients.

Competence in the Diagnosis of Endodontic Treatment

In the diagnosis of endodontic pathosis:

- **Intent Statement:** The practicing dentist should be able to manage a patient with pathoses of pulpal and or periapical origin. The first step in this management is the diagnosis of the problem. The dentist should be able to assimilate the necessary subjective, objective, and radiographic information to establish both a pulpal and/or periapical diagnoses. Appropriate treatment or referral can only occur if the patient's signs and symptoms are properly diagnosed and understood as a biologic departure from health.
- **Intent Statement:** A practicing dentist should be able to provide/manage urgent/emergent care to patients experiencing signs and symptoms of pulp and or periapical pathoses, which can lead to pain and/or swelling; to include consultation and/or the provision of immediate appropriate referral if indicated.
- **Intent Statement:** The practicing dentist should be able to evaluate, diagnose, provide emergency care, or refer patients presenting with traumatic injuries. Clinicians are expected to know the traumatic dental injury protocols and recommendations published by the AAE and the International Association of Dental Traumatology (IADT).

Diagnostic Reasoning

Developing a diagnosis is a process of gathering information and applying the data to the individual patient and is the most critical step in dental treatment. This information is correlated from the patient's history of treatment, pain, trauma or restorative procedures, clinical examinations, results of clinical tests, and radiographic examination of the teeth and the surrounding tissues. By definition, diagnosis is both the process of identifying the presence of disease and naming the disease itself. In endodontics, a multitude of different pathologic entities exist that are distinguished in the diagnostic process, and establishing the correct diagnosis permits the implementation of an appropriate treatment regime. The basic endodontic diseases are associated with pathoses of the pulpal and/or periapical tissues and their related inflammatory processes. The diagnostic process begins with a patient interview and review of the medical history, dental history, and pain history. A thorough patient and pain assessment interview will often enable a clinician to differentiate between odontogenic and non-odontogenic pain. Non-odontogenic pain can often become chronic and debilitating in nature. Furthermore, this pain can be exacerbated by incorrect or unnecessary treatments that may result in the establishment of chronic pain pathways. When symptoms don't make sense, or do not correlate with normal odontogenic descriptors of pain, the clinician becomes obligated to get additional opinions from specialist colleagues before initiating endodontic treatment.

An accurate diagnosis is crucial for the development of a comprehensive treatment plan, including alternative options: no treatment, vital pulp treatment, nonsurgical root canal treatment, surgical root canal treatment, extraction, or referral. Pulpal and periapical testing should always be carried out to establish an accurate diagnosis. After making an endodontic diagnosis, ultimately, the clinician must answer two critical questions before progressing to treatment of a tooth or referral to a specialist: can the tooth be properly restored and do the supporting structures provide a reasonable prognosis?

Endodontic diagnoses always include both a pulpal and a periapical diagnosis and treatment should not be initiated without at least a tentative diagnosis and consent from the patient. In the majority of situations, a diagnosis can be reached that is sufficiently certain for treatment to proceed. In a minority of cases however, where there is conflicting evidence, or referred pain with an unknown etiology, it is better to let some time pass for the condition to clarify than to make an incorrect diagnosis or start an inappropriate or unnecessary treatment. Without a diagnosis, there can be no treatment plan.

Patient Interview

There are several critical aspects to the patient interview, including the chief complaint, history of the chief complaint, medical history, and dental history. Only a recent myocardial infarct, uncontrolled hypertension, and uncontrolled diabetes have been identified as systemic contraindications for endodontic treatment. However, a thorough and current medical history is mandatory before any dental treatment can begin. The medical history is of great importance in order to determine whether medical consultation with the patient's physician may be necessary, or how systemic conditions may impact healing or prognosis. It is important to confirm the patient's health status to coordinate treatment and to evaluate if pre-medication is necessary before diagnostic examination or clinical treatment can be undertaken. While some patients may require pre-medication with systemic antibiotics prior to treatment, other patients can present with allergies requiring an alternate medication or drug. The potential effect of electrically powered instruments such as ultrasonic units or electrosurgical instruments on a patient's pacemaker function, or cochlear ear implants must be carefully evaluated before treatment.

The dental history can help direct a diagnosis and it is important to inquire if a patient has had any recent dental treatment or injuries. A fractured tooth as a result of caries can frequently result in a near or actual pulp exposure and often leads to an uncomplicated diagnosis. Evaluating radiographs and recognizing the extensive nature of restorations; looking at the quality, depth and structural impact of past restorations can provide meaningful clues to the possibility of irreversible pulpal inflammation. To obtain all facts that are essential, the art of listening carefully and acting in a caring manner cannot be overemphasized. Treatment decisions must be made considering all patient treatment modifiers, such as oral health and hygiene, finances, esthetics, expectations of treatment procedures, and function.

A chief complaint is often the reason a patient seeks care and it is important for the patient to express this in their own words and then record this in the treatment record. A clear understanding of a patient's motivation for seeking care and of their expectations will help alleviate misperceptions and avoid poor communication in the dentist-patient relationship.

The character of the complaint; the location; the inception; provoking or attenuating factors, as well as the frequency, intensity, duration; whether the pain is spontaneous or stimulated and if it is getting better or worse, are all important features of the patient interview. A majority of endodontists will rely on a judgment of irreversible inflammation when the pain has two major characteristics; complaints of spontaneity and intensity are fundamental descriptors that link the biology of irreversible pulpal inflammation to symptoms. It is important to realize that pain of endodontic origin can at times be extremely intense and debilitating; inception of symptoms is typically short in duration as opposed to months or years seen in chronic pain syndromes. Pulpal/periradicular pain will characteristically become focused on a particular tooth or dissipate only to return at a later date.

Traumatic Dental Injuries (TDIs) have to be assessed carefully as treatment provided immediately after injury has a major influence on future prognosis. Generally, treatment can be accomplished without significant difficulty but may be complicated, requiring specialty expertise. A primary diagnosis based upon an accurate assessment must be carried out competently following established guidelines.

Most practitioners in the medical professions consider all diagnoses as the art and science of identifying departure from health and its cause. Inherent in this process is the identification of all conditions that may produce the same signs and symptoms. Because the testing for health or disease of a pulpal circulation encased in a mineralized exterior can be challenging, all information elicited must be interpreted indirectly from the patient response to a stimulus placed externally to the tooth. This is subjective and varies between patients and within patients as they age. By and large, pulpal testing is more valid in determining teeth that are free of disease and less accurate in identifying teeth with pulpal pathoses. However, diagnostic tests that include thermal and electric pulp testing, palpation, percussion, periodontal probing, a bite test, and radiographic examination and interpretation will serve to provide multiple confirmations that can build confidence in a diagnosis. Signs and symptoms of odontogenic pain include constant pain, prolonged

sensitivity to temperature changes, an extruded feeling in the tooth, and tenderness to biting pressure, impaired mouth opening, tooth mobility, and tenderness to palpation in the apical area. These signs and symptoms in various combinations are highly accurate predictors of odontogenic disease.

Treatment Records

In determining the quality of endodontic records and clinician responsibility for those records, a statement that should define any practitioner of endodontics can be stated as: **“Good clinicians keep good records.”** Records of endodontic treatment serve as important documentation to guide the clinician’s objective data through the correct diagnostic and treatment path. Documentation is essential to attaining an accurate log of events and decision-making as endodontic diagnosis is a clinical diagnosis based on the database gathered. Over time, the database may change as more information is obtained, possibly indicating a different diagnostic classification.

The dental record must contain sufficient information to identify the patient, support the diagnosis, justify the treatment, document the course and result of treatment and be designed to protect the patient’s welfare. Records also are fundamental means of communication among health care professionals, should the patient be referred for continued or follow-up care. A systematic and complete record should contain:

- A thorough review of the patient’s medical and dental history
- Chief complaint(s), including onset, duration, frequency, type and intensity of any pain
- Pulpal and periodontal diagnostic tests performed
- Objective clinical examination findings
- Differential diagnoses and definitive diagnosis
- Radiographs of diagnostic quality
- The treatment plan, alternative options and prognosis
- Documentation of the course of treatment

These are essential components of a quality record that support the doctor-patient interaction. When other factors affect the prognosis of any tooth diagnosed for endodontic treatment, such as the tooth’s strategic value, restorability, supporting structures, or the tooth’s proximity to vital structures, the clinician should consider further consultation with an endodontist or other specialists,

including a prosthodontist, periodontist, pediatric dentist, oral pathologist, or radiologist with advanced imaging, before initiating endodontic treatment.

Imaging and Diagnosis

The collection and collation of pertinent information is central to the establishment of an appropriate and accurate diagnosis in all fields of medicine and dentistry. Radiographs are prescribed only after the clinical examination to ensure the proper projections are obtained. Preoperative radiographs are an indispensable part of diagnostic procedures in root canal treatment. A simple bitewing radiograph will always give the truest projection of the pulp chamber and its depth, along with the depth of interproximal caries, and prior restorations. The bitewing provides additional information about the teeth of the opposing arch as well as the arch under investigation and frequently can direct the clinician’s eye to a possible problem on an opposing tooth that might be overlooked with periapical films alone. However, recognition and diagnosis of periapical disease on conventional radiographs can be a challenge. Well-angulated periapical films should be taken with the cone directed straight on, mesio-oblique, and disto-oblique. This technique often reveals and clarifies the three-dimensional morphology of the tooth and identifies anatomic complexities. Digital radiography and other imaging technologies afford an enhanced variety of software features significantly augmenting radiographic diagnostics in identifying anatomical complexities. The clarity, color, contrast, and brightness of a digital image can be easily modified affording a further ability to interpret hidden, mineralized or untreated canals.

When a radiographic examination is performed or required, the practitioner assumes the responsibility to make accurate interpretations from good discernable images of diagnostic quality. It is a common understanding that pathoses as well as anatomic entities are often missed in two-dimensional radiographic surveys, both by the operator and the limitations of the technology when encountering differences in anatomic variation. Three-dimensional imaging such as cone beam computed tomography (CBCT) can image periapical lesions and other anatomical structures in horizontal, vertical and sagittal sections. The scanning devices responsible for these “limited field” 3-D images have greatly advanced our understanding of the anatomic complexities in any given case, elucidating pre-operative intricacies and unseen pathoses and canal complications. When their utilization is indicated, the field of view (FOV) can be limited to several teeth and the resulting CBCT scans

can produce images with excellent contrast and clarity with limited radiation. One of the greatest causes of failure of molar endodontics is failure of the clinician to locate and treat all parts of the canal system. The appropriate radiographic imaging techniques (periapical and/or CBCT imaging) will provide the clinician who utilizes this technology with the information to address these shortcomings.

In difficult instances of diagnosis, such as internal or external resorption, which often superimposes itself over pulpal anatomy, a 3-D image defines very accurately the extent of the disease and the amount of resorptive invasion. Assessment of periradicular lesions in multi-rooted teeth and differentiating these lesions from non-odontogenic pathoses, as well as understanding size and distances, are now predictably possible with limited field cone beam imaging. In addition to spatial relationships of root apices to anatomical structures, accessory canals, location of root canals and canal obstructions can be viewed. The healing and repair of pathoses after non-surgical and surgical endodontics can be observed in a far more predictable manner, which can dramatically aid the clinician in treatment planning and predicting prognosis. In a very recently published study of retention outcomes on endodontic treatment of molars, these more difficult and complex teeth showed a ten-year survival rate that was statistically and significantly better when the treatment was accomplished by endodontists.

The ability of a clinician to assess, diagnose, and treatment plan traumatic dental injuries and known sequelae, such as mineralization and root resorption, places additional requirements for competence in this important arena of dental trauma. All dental practitioners should be able to evaluate, diagnose and provide emergency care in instances of dental trauma as well as develop a comprehensive treatment plan. Clinicians are expected to learn fundamental protocols and recommendations published by the International Association of Dental Traumatology (IADT) and the AAE. Diagnosis and appropriate treatment of root resorption is complex and in complying with contemporary standards of practice, requires 3D imaging. The clinician should be able to make a differential diagnosis of the different types of root resorption and provide the proper management or the appropriate referral to a specialist.

Competence in Endodontic Treatment Planning

In the determination of whether to initiate treatment or refer:

- **Intent Statement:** By using the *AAE Case Difficulty Assessment Form and Guidelines* (CDAF) to establish a rationale for appropriate treatment and or assess the need for referral due to anticipated case complexity, the practicing dentist should be able to apply the established criteria to each individual case and determine the degree of difficulty in providing non-surgical and surgical root canal treatment.
- **Intent Statement:** In the diagnosis and appropriate treatment of root resorption as a sequelae of trauma, the practicing clinician should be capable of making a differential diagnosis of the different types of root resorption, as well as have knowledge as to the proper management for such resorptive lesions, including referral to a dental specialist as necessary after appropriate imaging including 3D technologies.

Guidelines utilized in endodontic treatment planning are designed to describe the clinical quality and professional performance of a procedure without regard to the practitioner being a general dentist or specialist. Dental practitioners are encouraged to provide endodontic treatment consistent with their education, clinical experience and contemporary standards. The standard of practice and best practices for various services may change with time and it is the responsibility of practitioners to be aware of such changes for those procedures they perform.

The practitioner, when confronted with a case beyond their capabilities, has the following options and ethical responsibilities:

- Discuss all relevant benefits and risks of treatment options and limitations with the patient, ensuring that the information is understood before the patient is asked to give an informed consent
- Refer the patient for consultation and/or treatment to an endodontist
- Upgrade one's skills to meet the standard of practice as determined by the endodontic specialty

Endodontic treatment procedures based upon an established treatment plan should be of such quality that predictable and favorable results will routinely occur. Consideration must always be given to various treatment modalities which meet the standard of practice but are favored by individual practitioners. Patients should be cognizant that any treatment modality, however acceptable, may not achieve an acceptable treatment outcome in each and every case. There are a number of other factors including biologic, intrinsic, and psychological that may preclude a successful result.

- The pre-existing state of the patient's medical and dental condition
- Patient compliance and follow-through
- Complications and recognized risks of the procedures being performed

In traumatic dental injuries, diagnosis and treatment planning is often complex, time consuming, expensive and requires multidisciplinary approaches. All dental professionals are expected to accurately diagnose, provide appropriate emergency care and develop a treatment plan for traumatically injured teeth and their supporting structures. Providing urgent/emergent treatment that is inappropriate may compromise the long-term outcome.

All departures from expected outcomes should be recorded in the patient records at the time of service and patients should be advised of compromised results as soon as the dentist is aware of the facts. In these circumstances, all information presented to the patient must be documented.

Case Assessment in Treatment Planning

There are many factors that influence degrees of difficulty and risks of endodontic treatment. Recognition of these factors prior to the initiation of treatment helps patients and practitioners understand the complexities that may be involved in individual cases. **Endodontic treatment on a hopeless tooth is just as unethical as extracting a restorable tooth and replacing it with an implant.**

The CDAF is a practical tool that makes case selection efficient, consistent, and easy to document, providing a roadmap for when a generalist should treat or refer to an endodontist. The CDAF specifically states that "technology, instruments and materials are not a replacement for clinical skill and experience, but rather adjuncts that a practitioner can employ to reach a desired goal." The CDAF is intended to assist practitioners with endodontic treatment planning, but can also be used to help with referral decisions and

record keeping. The assessment form identifies three categories of considerations which may affect treatment complexity: patient considerations, diagnostic and treatment considerations, and additional considerations. Within each category, levels of difficulty are assigned based upon potential risk factors.

The levels of difficulty, ranging from minimal to moderate as well as high difficulty, are sets of conditions that may not be controllable by the dentist. General dentists who render endodontic care should be competent to treat minimal difficulty and experienced general dentists may treat the moderate difficulty cases, but should always consider referral of these cases as well as high difficulty patients to endodontic specialists. It is extremely important that any dental practitioner recognize the limits of their skill and expertise in order to protect patients and provide quality care. Patient considerations that may complicate treatment include medical complications, difficulties with anesthesia, behavioral management issues, limited opening and treatment complications. Additional considerations include previous endodontic treatment, a history of trauma, and periodontal-endodontic conditions.

Since endodontists set the standard of practice for conventional endodontics, if the endodontist's standard cannot be met, such as the need for microscopy, regenerative procedures, complex traumatic injuries, 3-D imaging for complex anatomy or the need for apical surgery, the generalist should refer the patient to an endodontist. Planned endodontic cases should not be doomed to failure due to a lack of understanding of what is required to produce a certain level of quality treatment. **Implants should never become an insurance policy for inadequate endodontic treatment.**

Endodontic Treatment Plan

Once an endodontic problem has been confirmed, the practitioner must develop a course of action that will eliminate the cause, have a favorable prognosis and a good long-term outcome.

Treatment is based on a thorough understanding and interpretation of all diagnostic information including patient history, clinical and radiographic data, and should consider the strategic importance of the tooth/teeth being considered. Other factors to consider are treatment complexities; anatomic complexities; periodontal status; structural integrity and restorability of the tooth; prognosis; patient factors such as age, attitude, motivation, anxiety,

limited jaw opening, gag reflex; and the administration of antibiotics, analgesics and/or anti-inflammatory agents when appropriate. Though the final decision will rest with the patient, the treatment plan must include all options; be presented in a language the patient understands; show valid reasons (based on the conditions) on which option is best; how the procedure will be done; how long it will take; what prognosis should be expected, and how much it will cost. The manner in which a case is presented will and should always be designed towards what is best for the patient and only the patient. In many situations, the dentist should be in communication with the endodontist prior to even proposing various treatment options to the patient.

Restorability

Careful consideration should be given to the final restoration as part of the diagnosis and treatment planning steps. Studies have suggested that the long-term prognosis for an endodontically treated tooth is equally dependent on the coronal restoration as well as the quality of the endodontic treatment itself. Patients are not well served if the endodontic treatment is successful but the tooth fails, and it has been demonstrated that loss of the coronal seal will result in a rapid recontamination of the root canal treated tooth.

In recent years, there has been a major change in philosophy regarding the restoration of endodontically treated teeth. Researchers and clinicians have begun to realize the importance of respecting the preservation of tooth structure and the biological properties of the components of the tooth, namely enamel, dentin, and cementum. Minimal tooth structure should be removed while achieving all of the goals of debridement, disinfection, and obturation.

Before commencing endodontic treatment, the clinician must consider a number of factors regarding the restoration of the tooth.

- Altered physical properties of tooth tissues following endodontic treatment
 - How much dentin will remain following caries and/or restoration removal and access cavity preparation?
 - The existence of a fracture/crack and the extent of the fracture/crack
 - What functional demands will be placed on the restored tooth?
- Will it be feasible to ensure that the biologic width can be respected when the new restoration is placed with adequate ferrule?
 - Can an ideal embrasure space and emergence profile be restored or maintained?
 - Does the patient understand that the endodontic treatment is essentially not complete until the permanent restoration is placed?

Much has been written about the structural integrity and strength of the endodontically treated tooth. It is widely believed that endodontically treated teeth must be restored to improve their prognosis and are more prone to fracture for a number of reasons:

- Weakening of the tooth due to loss of tooth structure, especially loss of marginal ridges
- Alteration in the physical properties of the tooth due to the effects of chemical irrigants such as hypochlorite and EDTA (ethylene diamine tetra-acetic acid)
- Microbial factors: effects of bacteria–dentin interactions
- Restorative factors: effect of post-core restorations
- Age factors: effect of age changes on dentin

Traumatic Dental Injuries (TDI)

Management of dental trauma remains a significant clinical challenge affecting all dental professionals alike. Falls, accidents and sport-related injuries are the most frequent causes of dental trauma with an estimated prevalence of 30%. Patients can present with a wide variety of injuries ranging from crown or root fractures, to injuries to the supporting periodontal structure, including luxations and avulsions. Treatment is often complex, time consuming, expensive and requires multidisciplinary approaches such as endodontic and periodontal treatments, surgery, orthodontic movements as well as esthetic coronal restoration. Pulp necrosis, root resorption and ankylosis are the most common sequelae causing a major clinical challenge due to the high risk of infraposition and under development of the alveolar bone. The generalist should be educated in prevention, diagnosis and treatment of traumatized teeth, including the need for advanced 3D technology for diagnosis and treatment planning. Outcome expectations of traumatized teeth are different than non-traumatized teeth.

Informed Consent

After an endodontic diagnosis is made, the benefits, risks, treatment plan, and alternatives to endodontic treatment, including any patient refusal of recommended treatment and the consequences of refused treatment, should be presented to the patient or the patient's guardian. This will document acceptance or informed refusal of treatment recommendations. The patient or guardian, along with a witness (who can be a staff member), should sign and date the consent form. Upon informing the patient of the diagnosis, recommended treatment plan, prognosis and risks, the dentist's responsibility is satisfied. A practitioner cannot be forced to perform dental services that the practitioner deems contrary to the patient's overall health. In short, the right of the patient to accept treatment is balanced by the right of the dentist to refuse treatment when both parties understand the rational consequences of their actions.

Competence in the Prognosis of Endodontic Treatment

In determining prognosis for endodontic treatment:

- **Intent Statement:** The practicing dentist should be able to forecast the outcome of initial nonsurgical root canal treatment based on the pulp and periapical diagnosis, tooth anatomy and morphology, remaining tooth structure, and periodontal support. In addition, the practicing dentist should be able to assess treatment outcomes through clinical and radiographic measures and identify healing vs. non-healing of non-surgical root canal treatment. When non-healing occurs, the dentist should be capable of identifying the etiology and recommend corrective treatment strategies or refer to an appropriate dental specialist.

Stedman's Medical Dictionary defines prognosis as "a forecast of the probable course and/or outcome of a disease." Establishing a prognosis is not an exact science, even with cases that appear favorable and where treatment meets the accepted standard of practice can have an unfavorable outcome. It is unrealistic to expect all endodontic treatment will be successful despite a clinician's best efforts. This process requires the clinician to have a broad understanding of evidence-based dentistry, the ability to collect all relevant clinical information, to understand all available treatment options, to communicate effectively with the patient and appropriate specialists, and act in a professional and ethical manner in the patient's best interest.

Establishing a prognosis is essential prior to treatment, during treatment, following treatment, and upon recall examination. The prognosis is unique to the patient and clinician providing care. Subsequent to obtaining a diagnostic database the generalist must conduct a case difficulty assessment, assess the knowledge and clinical skill required to perform the procedure, and consider specialty care to enhance the prognosis for difficult cases.

Interdisciplinary care can enhance patient outcomes and the use of enhanced technology such as microscopy, three-dimensional imaging, ultrasonics, regenerative procedures, and osteo-inductive materials can additionally enhance the prognosis of endodontic cases

Pre-treatment Prognosis

To establish a pre-treatment diagnosis, treatment plan and prognosis, the clinician must have an understanding of: clinical and radiographic criteria for determining pulp and periradicular pathosis and differentiating these from non-endodontic pathosis; having detailed knowledge of potential lesions that can mimic endodontic pathosis; establishing an etiology for pulp pathosis to include caries, trauma, developmental defects, coronal cracks and fractures, resorptive lesions, periodontal pathosis, and restorative treatment procedures; identifying the clinical signs and symptoms of pulp and periapical pathosis from non-endodontic pathosis; interpreting normal/abnormal test results and clinical findings; having a detailed knowledge of pulp and periradicular anatomy and morphology and variations by tooth group; understanding the case difficulty assessment criteria and the potential for referral to a specialist.

Post-treatment Prognosis

Following non-surgical treatment, the clinician must have an understanding of the criteria for successful treatment to include: clinical monitoring of the patient's signs and symptoms; identification of iatrogenic incidents during treatment: missed canals, loss of length, ledges, apical transportation, apical, lateral and furcal perforations, fractured instruments; the quality of obturation with adequate length, density, taper, and coronal seal.

Outcome assessment (one year and beyond):

The clinician must have an understanding of: clinical and radiographic criteria for determining success and non-healing following endodontic treatment to include; clinical signs and symptoms of pulp and periapical pathosis; normal/abnormal test results and clinical findings; radiographic evidence of pathosis; radiographic evidence of osseous regeneration; radiographic evidence of procedural errors in endodontic and restorative treatment; and coronal leakage.

The treatment options available for cases where non-healing has been established should include: nonsurgical retreatment, root-end surgery, perforation repair, guided tissue regeneration, hemi-section and root amputation, intentional replantation, extraction, and no treatment.

Measuring Competence

Demonstration of competence in endodontic prognosis (prediction of outcome) and outcome assessment (post-treatment evaluation) is demonstrated by the following knowledge, skills, and behaviors.

- Describe prognosis and outcome assessment based on the best available current evidence
- Recognizing restorability of a tooth and possible need for crown lengthening
- Evaluating periodontal status
- Assessing the quality of previous endodontic treatment
- Understanding past traumatic dentoalveolar injuries
- Recognizing the presence of incomplete crown/root fractures
- Assessing the presence of internal or external root resorption

In addition, the practicing dentist must be able to:

- Explain benefits, risks, alternatives, and prognosis of treatment options in terms that are appropriate to patient's background and knowledge of dentistry
- Compare prognosis and cost effectiveness of initial root canal treatment, retreatment, surgical treatment, and tooth replacement options
- Explain the difference between success and survival as outcome measures
- Determine patient preferences for treatment options

- Evaluate immediate post-treatment outcome and explain the influence of procedural errors, missed canals, quality of canal obturation, and significance of coronal restoration on treatment outcome
- Evaluate post-treatment healing and recognize situations where referral for possible treatment revision and/or surgery is indicated
- Describe potential causes of persistent pain following root canal treatment and explain diagnostic tests and methods to distinguish between pain of odontogenic origin and non-odontogenic pain

Suggested Bibliography by Topic

Standards of Practice, Case Assessment, Initial Treatment, Cost Effectiveness

1. American Association of Endodontists. Endodontic Case Difficulty Assessment and Referral. Chicago, IL; 2005. pgs. 1-4.
2. American Association of Endodontists. The Standard of Practice in Contemporary Endodontics. ENDODONTICS: Colleagues for Excellence. Chicago, IL. 2014. pgs. 1-12
3. American Association of Endodontists and American Academy of Oral and Maxillofacial Radiology. Joint Position Statement: Use of Cone Beam Computed Tomography in Endodontics 2015 Update.
4. American Association of Endodontists. Recommended Guidelines for the Treatment of Traumatic Injuries. 2013; aae.org.
5. Canadian Academy of Endodontics. Standards of Practice. Copyright / 1998 Canadian Academy of Endodontics; revised 2015. Winnipeg, MB.
6. Stedman's Medical Dictionary, 28th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.
7. Ricucci D, Loghin S, Siqueira JF, Jr. Correlation between clinical and histologic pulp diagnoses. J Endod 2014;40:1932-9.
8. Levin LG, Law AS, Holland GR, Abbott PV, Roda RS. Identify and define all diagnostic terms for pulpal health and disease states. J Endod 2009;35:1645-57.

9. Jaeger B, Reyes MR. Non-odontogenic Toothache and Chronic Head and Neck Pain. In: Ingle JI, Bakland LK, Baumgartner C, editors. *Ingle's Endodontics*. 6 ed. Ontario, Canada: B.C. Decker; 2008. p. 392-467.
10. von Eckardstein KL, Keil M, Rohde V. Unnecessary dental procedures as a consequence of trigeminal neuralgia. *Neurosurg Rev* 2015;38:355-60.
11. Newton CW, Hoen MM, Goodis HE, Johnson BR, McClanahan SB. Identify and determine the metrics, hierarchy, and predictive value of all the parameters and/or methods used during endodontic diagnosis. *J Endod* 2009;35:1635-44.
12. Siedberg BH. The Law and Endodontics. In: Ingle JI, Bakland LK, Baumgartner C, editors. *Ingle's Endodontics*. 6 ed. Ontario, Canada: B.C. Decker; 2008. p. 86-104.
13. Ng YL, Mann V, Gulabivala K. Tooth survival following non-surgical root canal treatment: a systematic review of the literature. *Int Endod J* 2010;43:171-89.
14. Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature – Part 2. Influence of clinical factors. *Int Endod J* 2008;41:6-31.
15. Ricucci, Mannocci F, Ford TR. A study of periapical lesions correlating the presence of a radiopaque lamina with histological findings. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006;101:389-94.
16. Todd R. Cone beam computed tomography updated technology for endodontic diagnosis. *Dent Clin North Am*. 2014;58:523-43.
3. Andersson L, Andreasen JO, Day P, Heithersay G, Trope M, Diangelis AJ, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. *Dent Traumatol* 2012;28:88-96.
4. Diangelis AJ, Andreasen JO, Ebeleseder KA, Kenny DJ, Trope M, Sigurdsson A, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations of permanent teeth. *Dent Traumatol* 2012;28:2-12.
5. Malmgren B, Andreasen JO, Flores MT, Robertson A, DiAngelis AJ, Andersson L, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 3. Injuries in the primary dentition. *Dent Traumatol* 2012;28:174-82.
6. American Association of Endodontists. The recommended guidelines of the American Association of Endodontists for the treatment of traumatic dental injuries. Chicago, IL; 2013. p. 1-16.
7. Cohenca N, Simon JH, Roges R, Morag Y, Malfaz JM. Clinical indications for digital imaging in dento-alveolar trauma. Part 1: traumatic injuries. *Dent Traumatol* 2007;23(2):95-104.
8. Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature – Part 1. Effects of study characteristics on probability of success. *Int Endod J* 2007;40:921-39.
9. Lazarski MP, Walker WA, 3rd, Flores CM, Schindler WG, Hargreaves KM. Epidemiological evaluation of the outcomes of nonsurgical root canal treatment in a large cohort of insured dental patients. *J Endod* 2001;27:791-96.
10. Salehrabi R, Rotstein I. Endodontic treatment outcomes in a large patient population in the USA: an epidemiological study. *J Endod* 2004;30:846-50.
11. Gilbert GH, et al. Outcomes of root canal treatment in Dental PBRN practices. *General Dentistry* 2010;58:28-36.
12. Del Fabbro M, Taschieri S, Testori T, Francetti L, Weinstein RL. Surgical versus non-surgical endodontic re-treatment for periradicular lesions. *Cochrane Database of Systematic Reviews* 2007, Issue 3. Art. No.: CD005511.

Treatment Planning, Retreatment, Microsurgery, Decision Making

1. Venskutonis T, Plotino G, Juodzbaly G, Mickeviciene L. The importance of cone beam computed tomography in the management of endodontic problems: a review of the literature. *J Endod* 2014;40:1895-1901.
2. Ee J, Fayad MI, Johnson BR. Comparison of endodontic diagnosis and treatment planning decisions using cone-beam volumetric tomography versus periapical radiography. *J Endod* 2014;40:910-6.

13. Torabinejad M, Corr R, Handysides R, Shabahang S. Outcomes of nonsurgical retreatment and endodontic surgery: a systematic review. *J Endod* 2009;35:930-7.
 14. Ng YL, Mann V, Gulabivala K. Outcome of secondary root canal treatment: a systematic review of the literature. *Int Endod J* 2008;41:1026-46.
 15. Salehrabi R, Rotstein I. Epidemiological evaluation of the outcomes of orthograde endodontic retreatment. *J Endod* 2010;35:790-2.
 16. Panitvisai P, Parunnit P, Sathorn C, Messer HH. Impact of a retained instrument on treatment outcome: a systematic review and meta-analysis. *J Endod* 2010;36:775-80.
 17. Setzer F, Shah S, Kohli M, Karabucak B, Kim S. Outcome of Endodontic Surgery: A Meta-analysis of the Literature – Part 1: Comparison of traditional root-end surgery and endodontic microsurgery. *J Endod* 2010;36:1757-63.
 18. Setzer F, et al. Outcome of Endodontic Surgery: A Meta-analysis of the Literature – Part 2: Comparison of Endodontic Microsurgical techniques with and without Use of Higher Magnification. *J Endod* 2012;38:1-10.
 19. Tsesis I, et al. Effect of Guided Tissue Regeneration on the Outcome of Surgical Endodontic Treatment: A Systematic Review and Meta-analysis. *J Endod* 2011;37:1039-45.
 20. Tsesis I, et al. Outcomes of surgical endodontic treatment performed by a modern technique: an updated meta-analysis of the literature. *J Endod* 2013;39:332-9.
 21. Kang M, et al. Outcome of nonsurgical retreatment and endodontic microsurgery: a meta-analysis. *Clin Oral Invest* 2015;19:569-82.
 22. Zitzmann NU, Krasti G, Hecker H, Walter C, Waltimo T, Weiger R. Strategic considerations in treatment planning: deciding when to treat, extract, or replace a questionable tooth. *J Prosthet Dent* 2010;104:80-91.
- Outcomes, Risk Factors, Prognosis, Implants**
1. Burry JC, Stover S, Eichmiller F, Bhagavatula P. Outcomes of Primary Endodontic Therapy Provided by Endodontic Specialists Compared with Other Providers. *J Endod*, 2016;42:702-5.
 2. Kishen A. Mechanisms and risk factors for fracture predilection in endodontically treated teeth. *Endod Topics*. 2006;13:57–83.
 3. Vaz de Souza D, Schirru E, Mannocci F, Foschi F, Patel S. External Cervical Resorption: A Comparison of the Diagnostic Efficacy Using 2 Different Cone-beam Computed Tomographic Units and Periapical Radiographs. *J Endod* 2017;43:121-5.
 4. Cohenca N, Simon JH, Mathur A, Malfaz JM. Clinical indications for digital imaging in dento-alveolar trauma. Part 2: root resorption. *Dent Traumatol* 2007;23:105-13.
 5. De Paula-Silva FWG, Wu M-K, Leonardo MR, Bezerra da Silva LA, Wesselink, PR. Accuracy of periapical radiography and cone-beam computed tomography scans in diagnosing apical periodontitis using histopathological findings as a gold standard. *J Endod*; 2009;35:1009-12.
 6. Peters CI, Peters OA. Cone beam computed tomography and other imaging techniques in the determination of periapical healing. *Endod Topics* 2013;29:57-75.
 7. Giannobile WV, Lang NP. Are Dental Implants a Panacea of Should We Better Strive to Save Teeth? *J Dent Res* 2016;95:5-6.
 8. Torabinejad M, Anderson P, Bader J, Brown LJ, Chen LH, Goodacre CJ, Kattadiyil MT, Kutsenko D, Lozada J, Patel R, Petersen F, Puterman I, White SN. Outcomes of root canal treatment and restoration, implant supported single crowns, fixed partial dentures, and extraction without replacement: a systematic review. *J Prosthet Dent* 2007;98:285-311.
 9. Torabinejad M, et al. Tooth Retention through Endodontic Microsurgery or Tooth replacement Using Single Implants: A Systematic Review of Treatment Outcomes. *J Endod* 2015;41:1-10.
 10. Doyle SL, Hodges JS, Pesun IJ, Law AS, Bowles WR. Retrospective cross sectional comparison of initial nonsurgical endodontic treatment and single-tooth implants. *J Endod* 2006;32:822-7.
 11. Doyle SL, Hodges JS, Pesun I, Baisden MK, Bowles WR. Factors affecting outcomes for single-tooth implants and endodontic restorations. *J Endod* 2007;33:399-402.
 12. Iqbal MK, Kim S. A review of factors influencing treatment planning decisions of single-tooth implants versus preserving natural teeth with nonsurgical endodontic therapy. *J Endod* 2008;34:519-29.

13. Morris MF, Kirkpatrick TC, Rutledge RE, Schindler WG. Comparison of nonsurgical root canal treatment and single-tooth implants. *J Endod* 2009;35:1325-30.
14. Zitzmann NU, Krasti G, Hecker H, Walter C, Weiger R. Endodontics or implants? A review of decisive criteria and guidelines for single tooth restorations and full arch reconstructions. *Int Endod J* 2009;42:757-74.
15. Pennington MW, Vernazza CR, Shackley P, Armstrong NT, Whitworth JM, Steele JG. Evaluation of the cost-effectiveness of root canal treatment using conventional approaches versus replacement with an implant. *Int Endod J* 2009;42:874-83.
16. Kim SG, Solomon C. Cost-effectiveness of Endodontic Molar Retreatment Compared with Fixed Partial Dentures and Single-tooth Implant Alternatives. *J Endod* 2011;37:321-5.