Quality Resource Guide

Managing Complications During Root Canal Procedures

Author Acknowledgements

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MetLife designates this activity for 2.**0 continuing education credits** for the review of this Quality Resource Guide and successful completion of the post test.

Educational Objectives

Following this unit of instruction, the practitioner should be able to:

1. Discuss difficulties in achieving profound anesthesia for root canal procedures.
2. Identify the major complications encountered during root canal procedures and state methods for their prevention and management.
3. Discuss the levels of case difficulty and relate them to case assessment criteria.
4. Identify the causes of instrument separation and describe methods that can be used to prevent separation.
5. Discuss the importance of establishing a pathway (glidepath) in the root canal system prior to the application of shaping and cleaning instruments.
6. Discuss the implications and potential concerns associated with multiple uses of endodontic intracanal instruments.
7. Describe the circumstances that impact on the prognosis of a case when an instrument may separate and discuss the management of such.
8. Discuss the prognosis of cases in which the roots or crowns have been perforated and detail the important treatment considerations.
9. Discuss the causes of material extrusion beyond the root apex and describe the management of this complication.
10. Detail strategies for the management of pain and/or swelling that may occur following root canal procedures.
11. Detail and discuss protocols and strategies for the judicious and effective use of antibiotics during root canal procedures.

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The content of this Guide is subject to change as new scientific information becomes available.

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Introduction

Preventable complications within the delivery of contemporary root canal procedures include:

- Failure to achieve profound anesthesia
- Recognition as to when restorations must be removed and assessment of the integrity of the remaining tooth structure prior to commencement of root canal procedures
- Failure to establishing a patent pathway in the root canal prior to placement of the rotary enlarging, shaping and cleaning files
- Perforations of the root or crown of the tooth
- Separated instruments and the assessment of their impact on successful outcomes
- Aspiration or swallowing of intracanal instruments and irrigation solutions
- Extrusion of materials beyond the confines of the root canal
- Fractures
- Acute pain
- Swelling/lymphadenopathy
- Inappropriate antibiotic use during root canal procedures

The purpose of this guide is to identify and discuss these complications from a problem-solving, preventive and management standpoint.

While each root canal procedure has some degree of inherent risk, the standard of care requires that practitioners consider patient and tooth conditions that may complicate treatment and adversely affect the outcome. Levels of case difficulty have been detailed by the American Association of Endodontists (**Table 1**) and case difficulty assessment forms are available (**Attachment 1**).*

Recognition of the inherent risks in these choices, acquired at the time of diagnosis and treatment planning should be communicated to the patient to obtain informed consent (**Attachment 2**). After reviewing the case assessment with the patient, referral to a specialist for case management may be indicated.

Failure to Achieve Profound Anesthesia in the Presence of Irreversible Pulpitis[1-4]

Many reasons have been set forth for the failure to achieve profound anesthesia prior to the commencement of root canal procedures. The major focus of publications has been the scenario in which the mandibular first molar is diagnosed as having a symptomatic pulpitis with acute apical periodontitis. In its most intense state, this clinical situation is usually characterized by spontaneous pain, pain to biting, and pain that is stimulated by cold that persists until analgesics are used to control the discomfort. Often there is pain to pressure and there may be a feeling of swelling or fullness in the tooth. The reasons for failure to achieve a level of anesthesia necessary to perform root canal procedures comfortably in this situation are not fully understood. One explanation indicates that a patient's apprehension, in combination with tissue inflammation, significantly lowers their pain threshold to a level beneath the anesthetic's effectiveness. Other explanations include the nature of the anesthetic solution, the position of the bevel on the needle and extraneous innervations. To date this clinical scenario continues to be perplexing for many clinicians.

Possibly the most important aspect of this problem is the position of the anesthetic needle along the medial surface of the ramus of the mandible during injection. This is especially important in those patients with a thickened or widened ascending anterior border of the ramus. Additionally, there may be an accentuated sharp spine of bone located over the mandibular foramen that can deflect the needle in a medial and posterior direction. When either of the anatomical impediments is present, the needle usually deviates to a location posterior to the mandibular foramen, diminishing the impact of the anesthetic solution.

The following actions can enhance the provision of profound anesthesia on a predictable basis for a patient with irreversible pulpitis and the possible anatomical variations:

- Palpate the anterior border of the ramus thoroughly to determine the nature of the bony architecture.

Table 1 - Levels of Difficulty

Minimal Difficulty	Preoperative condition indicates routine complexity uncomplicated. These types of cases would exhibit only those factors listed in the "Minimal Difficulty" category. Achieving a predictable treatment outcome should be attainable by a competent practitioner with limited experience.
Moderate Difficulty	Preoperative condition is complicated, exhibiting one or more patient or treatment factors listed in the "Moderate Difficulty" category. Achieving a predictable treatment outcome will be challenging for a competent, experienced practitioner.
High Difficulty	Preoperative condition is exceptionally complicated, exhibiting several factors listed in the "Moderate Difficulty" category or at least one in the "High Difficulty" category. Achieving a predictable treatment outcome will be challenging for even the most experienced practitioner with an extensive history of favorable outcomes.

*

- Determine the anatomy of the pterygomandibular fascial space.
- Avoid injury to the temporalis and medial pterygoid muscles that border the space; the bony anterior ramus of the mandible creates the lateral border of the pterygomandibular fold, which is obvious when the patient opens wide, and serves as the medial landmark for the medial pterygoid muscle.
- Direct the injection through the mucous membrane lateral to the pterygomandibular fold and medial to the greatest concavity of the anterior bony ramus; doing so will avoid injury to the muscles and usually achieves a good level of anesthesia.
- Retract the needle slightly after placing the needle to its desired position, and once the bony wall of the ramus has been contacted. Careful and slow aspiration is indicated, as the needle is in the highly vascular infratemporal fossa. If blood is drawn into the syringe, the process is repeated.
- Administer injections slowly.

A plethora of studies exist that address the use of multiple injections at various sites and use of different anesthetic solutions to obtain predictable anesthesia for the mandibular molar with irreversible pulpitis. These include the use of injections into the mylohyoid region, into areas located higher on the medial border of the ramus, periodontal ligament injections and intraosseous injections. All of these have limitations and their use alone, or in combination, is no guarantee that profound anesthesia will be predictably achieved. Variations in solutions have included the use of 2% lidocaine and 0.5 % bupivacaine, 2% lidocaine and 4% articaine, or just 4% articaine. While there does not appear to be significant differences in achievement of anesthesia when using lidocaine, bupivacaine or articaine, there does appear to be greater success when multiple injections (inferior alveolar nerve block and periodontal ligament injection or intraosseous injection) are used. Many clinicians chose to go directly to an intraosseous injection. As a last resort an intrapulpal injection can be used with a high degree of success, however, this can be painful for the patient.

Failure to Recognize When Restorations Must Be Removed and Tooth Structure Assessed Prior to Commencement of Root Canal Treatment[5-7]

The major cause of pulpal demise in the restored tooth is the presence of bacteria and/or their irritational byproducts that cause either a slow destruction of the pulp or a rapid, acute, inflammatory response. While the presence of periodontal disease can also cause pulpal changes that may result in an irreversible pulpitis, this is usually a long-term process, which infrequently results in a symptomatic situation.

The carious process usually starts at the tooth-restorative interface and is most often undetectable clinically or radiographically. Yet when signs or symptoms are present, root canal treatment is usually indicated. In all cases indicated for root canal treatment the etiologic factors should be identified so they can be completely removed. This may mean in many cases the complete removal of old restorations, caries excavation, examination for dentin fractures, and the determination of restorability. The following list presents possible findings along with possible solutions prior to commencing root canal treatment:

Finding #1

Caries in particular tooth margins above the free gingival margin (FGM).

Solution #1

Excavate caries, exam remaining tooth structure, use caries detectors as necessary, and determine restorability.

Finding #2

Caries below the FGM, and in some cases, to the depth of the sulcus or crestal bone.

Solution #2

Excavate caries and probe to ensure soundness of the periodontium and integrity of furcation bone in posterior teeth; if the anatomy allows - perform crown-lengthening surgery to establish a 2 mm collar of tooth structure (ferrule) above the FRM and ensure the integrity of the biologic width; do not attempt to place new restorations into an area where the patient will not be able to clean it.

Finding #3

Craze or fracture lines in sound dentin.

Solution #3

Use 1% methylene blue to highlight the lines, use magnification to determine position and possible extent of the lines, use transillumination to determine if the tooth is actually divided into segments that cannot be retained or restored, probe in areas of fracture lines to see if they move

Table 2 - Anatomical Challenges to the Application of Instruments within the Root Canal

Root canal systems are rarely round in shape, with most being flattened or ribbon-shaped. This can lead to instrument binding if they are applied in an aggressive manner.
Root canals curve in three-dimensions that are not visible on the radiograph. Hand instruments should be curved prior to entry into the canal. Rotary instrument should be placed into a curved canal with minimal pressure and at low speeds (250 - 400 rpms).
Root canal that join present with an area where instruments are stressed and can bind in the canal, predisposing to fracture.
Root canals that exhibit abrupt deviations, bends or calcifications must be anticipated through radiographic assessment and initial penetration or pathfinding to prevent instrument binding, unwinding or fracture.

apically, look for darkened fracture lines on the marginal ridges and/or running across the roof or floor of the pulp chamber.

Separated Instruments[14-16]

This complication may be one of the most common and most vexing problems for the general dentist when using nickel-titanium rotary instruments. However, with the newer instruments undergoing various heat treatments, the incidence of fracture has been decreased. Regardless, there are precautions that can be taken to prevent this perplexing situation. Instrument separation usually occurs because of misuse or more specifically because of:

- excessive use of the instrument.
- excessive force being placed on the instrument.
- failure to understand the three-dimensional challenges of the root canal anatomy in which the instrument is being used, *e.g.*, curves, calcifications, joining of canals, abrupt deviations of bends (**Table 2**).

Prevention of instrument fracture requires knowledge of the physical characteristics of the instruments and guidelines for their proper use (**Table 3**). This is especially important with the wide variety of available nickel-titanium rotary instruments.

There is a growing body of evidence that supports single use for all intracanal instruments for two major reasons: 1) the ability to prevent instrument breakage on a more predictable basis, thereby eliminating need for a significant number of retreatment (nonsurgical and surgical) procedures; and, 2) once used the instrument will not function in the same manner as a new instrument and if used excessively the first time, the lifespan of the instrument will have been significantly compromised. While there have been published methods for instrument sterilization, adherence to the advocated protocols can be suspect in many practices.

Regarding the first concern, cases that require significant bending of the instrument or when it has been used excessively in tight, calcified or curved canals, dictate that the instrument be discarded after one use. The single use of root canal instruments is now standard in many European countries and Canada, as a standard for treatment.

Root canal instruments must be used according to the manufacturer's guidelines or DFUs (directions for use). Most major manufacturers are now labeling their instruments as "Recommended for single use only". Furthermore, there are no instruments that are designed to bore through calcified dentin. They must be used to carefully to enlarge the existing canal space without creating undo stress. With the advent of nick-titanium (NiTi) instruments, in particular rotary instruments, canals can now be accessed differently, using the crown-down technique of canal preparation that can minimize the stresses placed on the shaft of these instruments when used properly. Although this development has reduced the number of broken instruments, there still looms a potential problem with these newer systems, especially during misuse. Electric motors, designed to be used with these instruments, are programmed for torque applications that are compatible with new, sharp and unflawed instruments. While it is impossible to prevent breakage of root canal instruments in all cases, there are several precautions that can be implemented by the practicing dentist to minimize this occurrence, including:

- adopt a single use only philosophy for all instruments, but in particular for small (#08 -20 hand and 15 -25 rotary) instruments;
- establish a pathway or glide path for the NiTi rotary or reciprocating instrument with a small K-file to ensure canal patency - new instruments and files have been developed specifically for this purpose;
- minimize pressure on the instrument - both rotary and hand - during usage, especially when it is binding or resistance to apical movement is felt;
- exercise extreme caution when using hand, rotary or reciprocating instruments in complex challenging anatomical situations - it is in these areas that binding occurs more readily;
- use torque, speed control and automatic reverse features for devices that drive rotary instruments;

Table 3 - Guidelines for the Prevention of Instrument Fracture

Do not force instruments apically into the canal. Use minimal pressure twisting the instrument in a quarter turn fashion while teasing it apically.
Always have root canal irrigants present in the canal during penetration apically.
Use hand instruments prior to penetration with curves in the apical 2-3 mm of the cutting surface that reflect the nature of the canal curvature; or the use of glide path/pathfile rotary or reciprocating instruments is indicated.
Turn the instrument gently counterclockwise when binding is felt, to release the binding before removal.
Discard instruments when evidence of flaws, such as shiny areas or unwinding the flutes.
Establish a pathway in the canal with at least a #15 or 20 K-file prior to entry with a rotary file. The use of rotary or reciprocating pathway forming is strongly encouraged. When these are used, the application of rotary files or hand files for canal enlargement, shaping and cleaning is enhanced and common problems are prevented[8-10]
Discard the instrument If accidental bending or kinking occurs during use.
Small instruments, such as #08, 10, 15 and 20, whether hand or rotary often become worn or have been stressed beyond their limit even though wear or alterations may not be seen.

- follow the DFUs with all instruments;
- identify usage patterns for all instruments that are used more that once, and;
- inspect all instruments frequently, during and following use.

When instruments break, the clinician is faced with a complicated decision-making process in management that includes the determination of the:

- location of the broken instrument segment;
- cleanliness of the root canal system prior to breakage;
- size of the instrument;
- type of instrument; and
- operator's skill and expertise.

The breakage of a metallic instrument inside of a root canal is not a deviation from the standard of care or an automatic indication for periapical surgery. Based on the experience and expertise of the operator, many instruments can be removed from the root canal system (**Table 4**). However, in choosing to remove the segments, alterations in the root structure will occur that may weaken the root. The presence of a fractured instrument invariably places the case in a "high difficulty" category. The patient must be informed and given the opportunity to choose referral to a specialist

Regardless of the position of the fractured instrument, one must determine if the root canal was completely cleaned of pulp tissue, necrotic debris and disinfected prior to breakage and if there are any adverse clinical signs or symptoms.

Breakage of an instrument in a tooth that is isolated with a dental dam and whose root canals contained a vital, inflamed dental pulp is much different than when the breakage occurs in a tooth that is not isolated, awash with saliva, and whose dental pulp is infected or necrotic. When an instrument breaks and canal has been previously cleaned, filling of the canal to the level of the instrument is considered as an acceptable standard of care. This is followed by periodic evaluation of the tooth for at least 4 years. If symptoms or signs develop, periapical surgery may be indicated. From the time of breakage through continued follow-up evaluation and care, the patient should be informed of all aspects of treatment and their consequences.

Table 4 - Considerations in the Attempted Removal of Broken Instruments

Removal of instrument segments from the coronal one-third of the root is generally the easiest, provided at least 1/3 of the separated instrument can be exposed for grasping with minimal removal of tooth structure.
Removal of instrument segments that are positioned partially around a curve may possibly be removed if the coronal 1/3 of the separated instrument can be exposed without incurring a root perforation.
Removal of instrument segments positioned entirely apical to the canal curvature is usually impossible and surgery, in the presence of patient signs and symptoms will be indicated.

Table 5 - Perforation Considerations

The level of perforation impacts on the prognosis. Coronal-third perforations have the poorest prognosis because they threaten the sulcular attachment and pose a multitude of treatment challenges. This is especially true of furcation perforations.
Isolated, small perforations in the middle or apical third have a better prognosis or can be managed often with simple intracanal repairs. Sometimes surgery will be necessary.
Large perforations create challenges in their management, in particular, the degree of damage to the attachment apparatus at the time of the perforation and the establishment a seal.
Failure to repair a perforation immediately often leads to bacterial contamination or tissue damage with intracanal irrigating or disinfecting solutions, or further damage if intracanal instruments pass through the unidentified perforation.
The best material for perforation repair is Mineral Trioxide Aggregate (MTA) or one of the newer bioceramic materials if there is no sulcular communication.
With sulcular perforations, a surgical repair, crown lengthening or extrusion may be necessary.

Perforations of the Root or Crown of the Tooth[11-13]

A perforation is an invasion into the supporting periodontal structures that incites inflammation and potential loss of attachment. Perforations can significantly alter the prognosis of root canal procedures depending on their location and the status of the canal contents when the perforation occurred (**Table 5**). A perforation places the case in the category of "high difficulty" and the patient must be informed and given the opportunity to choose referral to a specialist. Just because a perforation has occurred does not mean the tooth is doomed to extraction.

Aspiration or Swallowing of Intracanal Instruments and Irrigation Solutions[17-19]

These treatment complications can, and should, be prevented with the placement of a properly adapted and secured dental dam for all root canal procedures. This is the standard of care. If an intracanal instrument is aspirated or swallowed, the patient should be immediately sent to a physician for evaluation. In the case of irrigating

solutions, the patient should drink 8 ounces of water immediately. There may be a coughing reflex that will subside in a few minutes. Have the patient continue with multiple glasses of water for 24 hours.

Extrusion of Materials[20-24]

Forceful extrusion of sodium hypochlorite, or air, past the end of the root into the periapical tissues can create severe complications. The initial response is usually rapid and is characterized by swelling, pain, interstitial hemorrhage and ecchymosis. When either of these situations occurs, treatment should terminate and the patient should be reassured. Management with antibiotics, antihistamines, analgesics and ice packs is indicated (**Table 6**).

Material extrusion may also include the pushing of filling materials (gutta-percha and sealer) or intracanal medicaments, such as calcium hydroxide into a sinus cavity or the inferior alveolar canal. With the former, observation is in order and if signs or symptoms develop, surgery may be necessary. While the calcium hydroxide is highly effective within the root canal, its presence within these vital structures may cause burning, pain and possible parasthesia for the patient. Analgesics are indicated initially for the symptoms; if they persist more than 2-3 days, referral to a specialist is indicated.

Fractures of Teeth During Obturation or Function[25-27]

Previously, root canal preparations were often limited to small shapes and sizes (.02 taper) and the use of large, tapered root canal spreaders for obturation predisposed the tooth to wedging and possible cracking or fracture during obturation. With current techniques of canal enlargement, shaping and cleaning, using variably tapered instruments, the incidence of fracture during obturation is reduced. However, to ensure tooth fractures do not occur however, two basic guidelines are offered:

1. Always fit the spreader or plugger loosely in the canal to the desired length prior to obturation to determine if there is binding. Binding of the compacting instrument is undesirable at any level; and
2. Compact the filling material slowly, and stop if binding is felt.

Table 6 - Pharmacological Management of Material Extrusion

Antibiotics Amoxicillin 500 mgs, 2 stat, 1 q6h; or Azithromycin 500 mg orally as a single dose on day 1, folllowed by 250 mg orally once a day on days 2 to 5 or Extended-release: 2 g orally once as a single dose
Antihistamines Diphenylhydramine 12.5 to 25 mgs, bid for 1-2 days
Analgesics Ibuprofen 800 mgs, 1 tab, q6h, PRN, pain; short-term use of ibuprofen is recommended.

Consideration must be given to the common method of shaping root canal to larger, tapered sizes, such as 0.04 and 0.06 or larger. When obturating these canals following the fitting of a master cone that is appropriately sized and matched to the canal shape, there is little room for a root canal spreader laterally to the cone. Therefore a vertical compaction or core-carrier technique is recommended. Techniques of obturation to prevent any possible fracture must be adopted in these situations.

Occlusal relationships of all teeth undergoing root canal procedures should be evaluated. The occlusion should be refined or reduced prior to treatment to minimize excessive and inadvertent forces on the tooth. Removal of tooth structure that is unsupported, or weakened by caries, prior to preparing the access opening is strongly recommended. Excessive removal of the root dentin during enlarging and shaping should be avoided, as this will weaken the root and predispose the tooth to fractures during or following treatment, usually prior to the placement of the final restoration.

Acute Pain[28-30]

The incidence of pain following root canal treatment is low (<5%), and acute pain is rare. When present it may be due to over-instrumentation of the canal and/or the expression of tissue debris, bacterial or materials beyond the root end. It could also be due to failure to locate an additional root canal that contains inflamed tissue. The best way to determine the problem is to see the patient and make a new assessment. The use of narcotics is generally discouraged as the problem is usually due to inflammation, for which anti- inflammatory drugs may suffice. In particular, the use of the regimen for moderate pain (**Table 7**) is more than adequate for patients who report with pain during or after root canal treatment. Good communication with the patient prior to the procedure as to any anticipated untoward sequelae is essential, as is being available post treatment for any concerns.

If a tooth was cracked or fractured during or after obturation, pain may be present. If there is numbness or tingling present in a mandibular premolar or molar, management with anti-inflammatory medications is indicated, as is referral to a specialist if symptoms continue beyond a week to ten days. Often this is a transitory response and time will allow for the reduction of inflammation around the nerve and a full recovery. In severe cases a surgical entry may be warranted to remove the offending materials and decompress the neural elements.

One of the most common reasons for pain is leaving the temporary restoration in the access opening in hyperocclusion. Always place the patient in a sitting position when evaluating the occlusion following the placement of a temporary restoration. What is important to consider in all situations is that the patient should be seen as soon as possible to address the problem properly.

Swelling/Lymphadenopathy[31]

While rare, this postoperative complication can occur if bacteria have been pushed beyond the root canal system. This is more common in one-

Table 7 - Assessing and Managing Acute Postoperative Pain

Is the tooth painful to biting? (reduce occlusion)
Is the tooth painful to thermal changes? (tissue remaining in the tooth or a canal not identified and inflamed pulp tissue is present – access tooth and clean canals)
Is there significant pressure felt by the patient? (open the tooth and look for drainage – consider apical trephination with a #20 – 25 K-file; in multi-rooted teeth open and look for additional canals)
Is the tooth mobile or elevated significantly in the socket? (acute alveolar abscess – antibiotics and analgesics)
Is the tooth fractured? (look for cracks in the temporary filling of the tooth – determine the extent of fracture – possible extraction)
Is there a fluctuant swelling? (incise and drain – antibiotics and analgesics)
Is there possible cement impaction around the tissue margins? (soreness and pain to palpation in the free gingival margin area and attached gingival – remove problem)
Is there a temporary crown impinging on the biological width? (remove and recontour)
Is there a radiolucency and significant pressure without swelling? (consider surgical trephination through the soft tissue and bone – usually requires a referral)
Is there numbness, tingling or pain that follows the course of the nerve? (use analgesics/anti-inflammatories)
Definitive signs of infection only? (antibiotics - Pen VK or Amoxicillin 500 mgs, 2 stat, 1 q6h; or Azithromycin - 500 mg orally as a single dose on day 1, followed by 250 mg orally once a day on days 2 to 5
Moderate pain? (analgesics - Ibuprofen 800 mgs q6h; or ibuprofen 400 mgs + acetaminophen 600 mgs q6h)
Severe pain? (analgesics - hydrocodone 5.0, 7.5 - 10.0 mgs + acetaminophen 500 mgs q 4-6h)
Severe pain from inflammation only? (corticosteroids - methyprednisolone 2 mg dose pack)

visit treatment of necrotic pulps. In multi-visit treatments, if there is coronal leakage of saliva-laden bacteria through the root canal, an infection may result. If the signs or symptoms dictate, an antibiotic and anti-inflammatory should be prescribed after the patient has been re-evaluated by the treating clinician. Resist the temptation to just provide the patient with analgesics and antibiotics after a telephone consultation.

Inappropriate Antibiotic Use During Root Canal Procedures[32,33]

The extensive use of antibiotics is usually not indicated during root canal procedures if the etiology of the problem can be identified and easily removed. Too often antibiotics are prescribed for pain that is due to inflammation and not due to infection. Likewise, antibiotics are needlessly prescribed when the clinician cannot determine the source of the patient's problem. This results in the potential for multidrug resistance to pathogenic bacteria and often disguises the real cause of the patient's problem. Antibiotics may be indicated during diagnosis and/or treatment for specific reasons, however a thorough examination and patient evaluation is essential before prescribing these drugs (**Table 8**). Likewise, there are general contraindications to their usage (**Table 9**) and the clinician is cautioned to use antibiotics wisely and in the best interest of the patient.

Table 8 - Specific Indications for Antibiotics

1. Fever > 100° F
2. Malaise
3. Lymphadenopathy
4. Trismus
5. Increased Swelling
6. Cellulitis
7. Osteomyelitis
8. Persistent Infection

Table 9 - General Contraindications to the Use of Antibioticss

1. Pain without signs & symptoms of infection
   a. Symptomatic irreversible pulpitis
   b. Acute periapical periodontitis
2. Teeth with necrotic pulps with or without a periapical radiolucency
3. Teeth with a sinus tract (chronic periradicular abscess)
4. Localized fluctuant swellings
5. To prevent the potential for a flare-up

Attachment 1

AAE Endodontic Case Difficulty Assessment Form and Guidelines

PATIENT INFORMATION

Name_____

Address_____

City/State/Zip_____

Phone_____

DISPOSITION

Treat in Office: Yes ☐ No ☐

Refer Patient to:

_____

Date:_____

Guidelines for Using the AAE Endodontic Case Difficulty Assessment Form

The AAE designed the Endodontic Case Difficulty Assessment Form for use in endodontic curricula. The Assessment Form makes case selection more efficient, more consistent and easier to document. Dentists may also choose to use the Assessment Form to help with referral decision making and record keeping.

Conditions listed in this form should be considered potential risk factors that may complicate treatment and adversely affect the outcome. Levels of difficulty are sets of conditions that may not be controllable by the dentist. Risk factors can influence the ability to provide care at a consistently predictable level and impact the appropriate provision of care and quality assurance.

The Assessment Form enables a practitioner to assign a level of difficulty to a particular case.

LEVELS OF DIFFICULTY

MINIMAL DIFFICULTY	Preoperative condition indicates routine complexity (uncomplicated). These types of cases would exhibit only those factors listed in the MINIMAL DIFFICULTY category. Achieving a predictable treatment outcome should be attainable by a competent practitioner with limited experience.
MODERATE DIFFICULTY	Preoperative condition is complicated, exhibiting one or more patient or treatment factors listed in the MODERATE DIFFICULTY category. Achieving a predictable treatment outcome will be challenging for a competent, experienced practitioner.
HIGH DIFFICULTY	Preoperative condition is exceptionally complicated, exhibiting several factors listed in the MODERATE DIFFICULTY category or at least one in the HIGH DIFFICULTY category. Achieving a predictable treatment outcome will be challenging for even the most experienced practitioner with an extensive history of favorable outcomes.

Review your assessment of each case to determine the level of difficulty. If the level of difficulty exceeds your experience and comfort, you might consider referral to an endodontist.

Attachment 1 - page 2

AAE Endodontic Case Difficulty Assessment Form

Criteria and Subcriteria	Minimal Difficulty	Moderate Difficulty	High Difficulty
A. PATIENT CONSIDERATIONS			
Medical history	☐ No medical problem (ASA Class 1*)	☐ One or more medical problems (ASA Class 2*)	☐ Complex medical history/serious illness/disability (ASA Classes 3-5*)
Anesthesia	☐ No history of anesthesia problems	☐ Vasoconstrictor intolerance	☐ Difficulty achieving anesthesia
Patient disposition	☐ Cooperative and compliant	☐ Anxious but cooperative	☐ Uncooperative
Ability to open mouth	☐ No limitation	☐ Slight limitation in opening	☐ Significant limitation in opening
Gag reflex	☐ None	☐ Gags occasionally with radiographs/treatment	☐ Extreme gag reflex which has compromised past dental care
Emergency condition	☐ Minimum pain or swelling	☐ Moderate pain or swelling	☐ Severe pain or swelling
B. DIAGNOSTIC AND TREATMENT CONSIDERATIONS			
Diagnosis	☐ Signs and symptoms consistent with recognized pulpal and periapical conditions	☐ Extensive differential diagnosis of usual signs and symptoms required	☐ Confusing and complex signs and symptoms: difficult diagnosis ☐ History of chronic oral/facial pain
Radiographic difficulties	☐ Minimal difficulty obtaining/interpreting radiographs	☐ Moderate difficulty obtaining/interpreting radiographs (*e.g.*, high floor of mouth, narrow or low palatal vault, presence of tori)	☐ Extreme difficulty obtaining/interpreting radiographs (*e.g.*, superimposed anatomical structures)
Position in the arch	☐ Anterior/premolar ☐ Slight inclination (<10°) ☐ Slight rotation (<10°)	☐ 1st molar ☐ Moderate inclination (10-30°) ☐ Moderate rotation (10-30°)	☐ 2nd or 3rd molar ☐ Extreme inclination (>30°) ☐ Extreme rotation (>30°)
Tooth isolation	☐ Routine rubber dam placement	☐ Simple pretreatment modification required for rubber dam isolation	☐ Extensive pretreatment modification required for rubber dam isolation
Morphologic aberrations of crown	☐ Normal original crown morphology	☐ Full coverage restoration ☐ Porcelain restoration ☐ Bridge abutment ☐ Moderate deviation from normal tooth/root form (*e.g.*, taurodontism, microdens) ☐ Teeth with extensive coronal destruction	☐ Restoration does not reflect original anatomy/alignment ☐ Significant deviation from normal tooth/root form (*e.g.*, fusion, dens in dente)
Canal and root morphology	☐ Slight or no curvature (<10°) ☐ Closed apex <1 mm diameter	☐ Moderate curvature (10-30°) ☐ Crown axis differs moderately from root axis. Apical opening 1-1.5 mm in diameter	☐ Extreme curvature (>30°) or S-shaped curve ☐ Mandibular premolar or anterior with 2 roots ☐ Maxillary premolar with 3 roots ☐ Canal divides in the middle or apical third ☐ Very long tooth (>25 mm) ☐ Open apex (>1.5 mm in diameter)
Radiographic appearance of canal(s)	☐ Canal(s) visible and not reduced in size	☐ Canal(s) and chamber visible but reduced in size ☐ Pulp stones	☐ Indistinct canal path ☐ Canal(s) not visible
Resorption	☐ No resorption evident	☐ Minimal apical resorption	☐ Extensive apical resorption ☐ Internal resorption ☐ External resorption
C. ADDITIONAL CONSIDERATIONS			
Trauma history	☐ Uncomplicated crown fracture of mature or immature teeth	☐ Complicated crown fracture of mature teeth ☐ Subluxation	☐ Complicated crown fracture of immature teeth ☐ Horizontal root fracture ☐ Alveolar fracture ☐ Intrusive, extrusive or lateral luxation ☐ Avulsion
Endodontic treatment history	☐ No previous treatment	☐ Previous access without complications	☐ Previous access with complications (*e.g.*, perforation, non-negotiated canal, ledge, separated instrument) ☐ Previous surgical or nonsurgical endodontic treatment completed
Periodontal-endodontic condition	☐ None or mild periodontal disease	☐ Concurrent moderate periodontal disease	☐ Concurrent severe periodontal disease ☐ Cracked teeth with periodontal complications ☐ Combined endodontic/periodontic lesion ☐ Root amputation prior to endodontic treatment

*American Society of Anesthesiologists (ASA) Classification System

Class 1: No systemic illness. Patient healthy.
Class 2: Patient with mild degree of systemic illness, but without functional restrictions, *e.g.*, well-controlled hypertension.
Class 3: Patient with severe degree of systemic illness which limits activities, but does not immobilize the patient.
Class 4: Patient with severe systemic illness that immobilizes and is sometimes life threatening.
Class 5: Patient will not survive more than 24 hours whether or not surgical intervention takes place.

www.asahq.org/clinical/physicalstatus.htm

Attachment 2

Doctors _____

Patient name_____
Birth Date _____/_____/_____

Consent for Non-Surgical Endodontic Treatment

Root canal therapy is an attempt to save a tooth which otherwise may require extraction. We like our patients to be informed about root canal treatment and its alternatives, and to have their consent before we begin treatment.

1. I hereby authorize Dr. _____ and any other agents or employees of _____, and such assistants as may be selected by any of them to treat the condition(s) described below:

_____

_____

2. The procedure(s) necessary to treat the condition(s) have been explained to me, and I understand the nature of the procedure(s) to be:

_____

_____

I agree to the use of local anesthesia and I understand that the endodontist will consult with me prior to administering any nitrous oxide analgesia and/or sedation.

3. The prognosis for the above procedure(s) was described as:

_____

4. I have been informed of possible alternative methods of treatment. Other treatment choices include no treatment at all, waiting for more definitive symptoms to develop and/or localization of pain, and tooth extraction.

5. The doctor has explained to me that there are certain inherent and potential risks in any treatment plan or procedure. I understand that the following may be inherent or potential risks for the treatment I will receive: swelling, sensitivity, bleeding, pain, infection, cold sores, numbness and/or tingling sensation in the lip, tongue, chin, gums, cheeks, and teeth which is transient but on infrequent occasions may be permanent; reactions to injections, changes in occlusion (biting); jaw muscle cramps and spasms (trismus), temporomandibular (jaw) joint difficulty, loosening of teeth, crowns or bridges; referred pain to ear, neck and head; nausea, vomiting, allergic reactions, delayed healing, sinus perforations and treatment failure. Fractures of the tooth (teeth) or crown(s) may occur during or after treatment.

During the course of treatment, there is the possibility of instrument separation (breakage) within the root canals; perforations (extra openings), damage to bridges, existing fillings, crowns or porcelain veneers; missed canals; loss of tooth structure in gaining access to canals, and cracked teeth. There are also

Attachment 2 - page 2

instances where a tooth may not be amenable to endodontic treatment at all, or which may require dental surgery. These may include, but are not limited to, blocked canals due to filling or prior treatment, natural calcifications, broken instruments, curved roots, periodontal (gum) diseased and splits or fractures of the teeth.

6. I understand that prescribed medications and drugs may cause drowsiness and lack of awareness and coordination, which may be exaggerated by the use of alcohol, tranquilizers, sedatives or other drugs. It is not advisable to operate any vehicle or hazardous device until recovered from the effects of any drugs or medications prescribed. Certain medications may cause hives and intestinal problems, and if any of these reactions occur, I am to call the endodontist immediately. The use of antibiotics may have an adverse action on the effect of birth control pills. I understand that it is my responsibility to notify the endodontist of any changes in my medical history.

7. It has been explained to me and I understand that a perfect result is not guaranteed or warranted and cannot be guaranteed or warranted. Occasionally, a tooth that has had root canal therapy may require re-treatment, surgery or even extraction. Following treatment, the tooth may be weak and subject to fracture. Permanent restoration (filling), crown, and possibly post and core, will be necessary to restore the tooth to function.

8. I have been given the opportunity to question the doctor concerning the nature of treatment, the inherent risks of the treatment, and the alternatives to this treatment.

9. This consent form does not encompass the entire discussion I had with the doctor regarding the proposed treatment, and I am making an informed decision of giving my permission to have non-surgical root canal treatment.

Patient's signature _____ Date _____

Doctor's signature _____ Date _____

Assistant's signature _____ Date _____

References

1. Kung J, McDonagh M, Sedgley CM. Does Articaine Provide an Advantage over Lidocaine in Patients with Symptomatic Irreversible Pulpitis? A Systematic Review and Meta-analysis. J Endod 2015;41(11):1784-1794.
2. Milani AS, Froughreyhani M, Rahimi S et al. Volume of Anesthetic Agents and IANB Success: A Systematic Review. Anes Prog 2018;65:16-23.
3. Gupta A Sahai A, Aggarwal V et al. Anesthetic efficacy of primary and supplemental buccal/lingual infiltration in patients with irreversible pulpitis in human mandibular molars: a systematic review and meta-analysis. J Dent Anesth Pain Med 2021;21(4):283-309.
4. Martin E, Nimmo A, Lee A, Jennings E. Articaine in dentistry: an overview of the evidence and meta-analysis of the latest randomised controlled trials on articaine safety and efficacy compared to lidocaine for routine dental treatment. BDJ Open 2021;7:27.
5. Abbott P. Assessing restored teeth with pulp and periapical diseases for the presence of cracks, caries and marginal breakdown. Austr Dent J 2004;49(1):33-39.
6. Tanaya, Dhawan P, Tandan P et al. Multidisciplinary approach in full mouth rehabilitation, J Res Med Dent Sci 2020;8(5):57-62
7. Mesko ME, Sarkis-Onofre R, Cenci M et al. Rehabilitation of severely worn teeth: A systematic review. J Dent 2016;48:9-15.
8. Cassim I, van der Wyver PJ.The importance of glide path preparation in endodontics: a consideration of instruments and literature. South Afr Dent J 2013;68(7):322-327
9. Wagle S, Ul Azeez M. Endodontic glide path: a review. Res Rev J Dent Sci 2017;5(2):13-16.
10. Plotino G, Nagendrababu V, Bukiet F et al. Influence of Negotiation, Glide Path, and Preflaring Procedures on Root Canal Shaping-Terminology, Basic Concepts, and a Systematic Review. J Endod 2020;46(6):707-729.
11. Regan JD, Witherspoon DE, Foyle D. Surgical repair of root and tooth perforations. Endod Topics 2005;11(1):152-178.
12. Saed SM, Ashley MP, Darcey J. Root perforations: aetiology, management strategies and outcomes. The hole truth. Brit Dent J 2016;230(4):171-180.
13. Rosen E, Tsesis I. Evidence-based decision-making in endodontics. Clin Dent Rev 2017;1(6). https://doi.org/10.1007/s41894-017-0006-0.
14. Murad M, Murray CA. Impact of Retained Separated Endodontic Instruments During Root Canal Treatment on Clinical Outcomes Remains Uncertain. J Evid Based Dent Pract 2011;11(2):87-88.
15. Paik S, Sechrist C, Torabinejad M. Levels of Evidence for the Outcome of Endodontic Retreatment. J Endod 2004;30(11):745-750
16. McGuigan MB, Louca C, Duncan HF. The impact of fractured endodontic instruments on treatment outcome. Brit Dent J 2013;214(6):285-289.
17. Boutsioukis C, Psimma Z, van der Sluis WM. Factors affecting irrigant extrusion during root canal irrigation: a systematic review. Int Endod J 2013;46(7):599-618.
18. Tanalp J, Güngör T. Apical extrusion of debris: a literature review of an inherent occurrence during root canal treatment. Int Endod J 2014;47(3):211-221.
19. Abusamaan M, Giannobile WV, Jhawar P et al. Swallowed and aspirated dental prostheses and instruments in clinical dental practice. A report of five cases and a proposed management algorithm. J Am Dent Assoc 2014;145(5):459-463.
20. Goldberg F, Cantarini C, Alfie D et al. Relationship between unintentional canal overfilling and the long-term outcome of primary root canal treatments and nonsurgical retreatments: a retrospective radiographic assessment. Int Endod J 2020;53(1):19-26.
21. Santoro V, Lozito P, De Donno A et al. Extrusion of Endodontic Filling Materials: Medico-Legal Aspects. Two Cases. The Open Dent J 2009;3:68-73.
22. Battrum D, Gutmann J. Implications, prevention and management of subcutaneous emphysema during endodontic treatment. Endod Dent Traumatol 1995
23. Balk SL, Stom J. Subcutaneous Emphysema after Root Canal Therapy Balkan J Stomatol 2012;16:10-15.
24. Khasnis SA, Kidiyoor KH, Patil AB, Kenganal SB. Vertical root fractures and their management. J Conserve Dent 2014;17(2):103-110.
25. Mardini A, Alhalabiah H. Effect of different root canal preparation and obturation methods on roots fracture resistance of endodontically treated teeth. (In vitro study) Int J Appl Dent Sci 2020;6(2): 287-290.
26. Topçuoğlu H-S, Arslan H, Keleş A Köseoğlu M. Fracture resistance of roots filled with three different obturation techniques. Med Oral Patol Oral Cir Bucal 2012;17(3):e528-532.
27. Sipavičiūtė E, Maneliebenė R. Pain and flare-up after endodontic treatment procedures Stomatologija 2014;16(1):25-30.
28. Alves Vde O. Endodontic flare-ups: a prospective study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;110(5):e68-72.
29. Gao X, Xin X, Li Z, Zhang W. Predicting postoperative pain following root canal treatment by using artificial neural network evaluation. Sci Rep. 2021;26;11(1):17243.
30. Jayakodi H, Kailasam S, Kyunaravaduvel K et a. Clinical and pharmacological management of endodontic flare-up. J Pharm Bioallied Sci 2012;4(suppl 2):S294-298.
31. Segura-Egea JJ, Gould K, Sen BH et al. Antibiotics in Endodontics: a review. Int Endod J 2017;50(12):1169-1184.
32. Germack M, Sedgley CM, Sabbah W, Whitten B. Antibiotic use in 2016 by members of the American Association of Endodontists: report of a national survey. J Endod 2017;43(10):1615-1622.

POST-TEST

Internet Users: This page is intended to assist you in fast and accurate testing when completing the "Online Exam." We suggest reviewing the questions and then circling your answers on this page prior to completing the online exam.

(2.0 CE Credit Contact Hour) Please circle the correct answer. 70% equals passing grade.

1. **Calcium Hydroxide is an extremely effective intracanal medicament. Pushing it past the root may**
   a. cause severe discomfort.
   b. enable biofilm destruction.
   c. kill extraradicular bacteria.
   d. form a scaffold for hard tissue formation.

2. **While there may be many considerations following instrument separation, what might be the most important consideration in the management of this mishap?**
   a. the type of the instrument. *i.e.*, rotary vs. hand instruments
   b. the amount of root damage that may occur when trying to remove the instrument
   c. treatment planning the wisest choice of management, including referral
   d. the length of the broken segment

3. **What type of tooth perforation may have the poorest prognosis?**
   a. An apical perforation in a tooth with a vital pulp.
   b. A lateral perforation above the crestal bone in a tooth with a necrotic pulp.
   c. A furcation perforation in a tooth with a necrotic pulp.
   d. A lateral perforation below the crestal bone in a tooth with a vital pulp.

4. **The use of antibiotics during endodontic procedures is determined by**
   a. the presence of a vital or necrotic pulp.
   b. previously prescribed antibiotics.
   c. patient signs and symptoms that warrant their use.
   d. the dosage and time of administration.

5. **Movement of irrigating solutions beyond the root apex that can cause tissue inflammation and patient distress can best be prevented by**
   a. enlarging, shaping and cleaning the root canal in a dry environment without irrigants.
   b. irrigate only in the coronal 1/3 of the canal.
   c. limiting irrigation to water.
   d. using minimal pressure during placement.

6. **The best way to manage minimal discomfort that may be present subsequent to root canal procedures is to**
   a. prescribe narcotics and antibiotics routinely prior to treatment for prevention.
   b. prescribe non-steroidal anti-inflammatory drugs routinely after treatment.
   c. prescribe the use of hot compresses and anti-inflammatory drugs.
   d. inform the patient prior to the procedure and be available to them if necessary post treatment.

7. **Nerve irritation or damage that may be caused by the overextension of root canal filling materials is best managed initially by**
   a. referral to a specialist if the symptoms do not subside in a few days.
   b. close patient observation and the use of narcotics for 2 weeks.
   c. antibiotics and antihistamines.
   d. immediate surgical intervention in an attempt to remove the material.

8. **Prevention of tooth fracture after root canal treatment is paramount. This is best accomplished by**
   a. always placing a temporary crown before root canal procedures.
   b. complete occlusal reduction of at least 1-2 mm.
   c. use of a bonded root canal filling material.
   d. restoring the tooth to function with an appropriate restoration as soon as possible after completion of root canal treatment.

9. **What is the most common reason for acute tooth pain following root canal procedures?**
   a. Tooth fracture
   b. Leaving the temporary restoration in hyperocclusion
   c. Bacterial leakage around a temporary filling
   d. Perforation

10. **The most common reason for failure to achieve profound anesthesia for a mandibular molar that exhibits an irreversible pulpitis is**
    a. using out-of-date anesthetic solutions.
    b. proper needle placement.
    c. injection into a muscle.
    d. inflammation.

Registration/Certification Information (Necessary for proper certification)

Name (Last, First, Middle Initial): _____

PLEASE PRINT CLEARLY

Street Address: _____ Suite/Apt. Number _____

City: _____ State: _____ Zip: _____

Telephone: _____ Fax: _____

Date of Birth: _____ Email: _____

State(s) of Licensure: _____ License Number(s): _____

Preferred Dentist Program ID Number: _____ ☐ Check Box If Not A PDP Member

AGD Mastership: ☐ Yes ☐ No

AGD Fellowship: ☐ Yes ☐ No Date: _____

Please Check One: ☐ General Practitioner ☐ Specialist ☐ Dental Hygienist ☐ Other

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4. Please rate the written materials and visual aids used.	☐	☐	☐	☐	☐	
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