Efficient Endodontics: Profitability Backed by Science

Diwakar Kinra
Welcome to the Greater New York Dental Meeting

COURSE REGISTRATION
Pre-registration is required for all continuing education courses with the exception of the “Live” Dentistry and Affiliated Groups. Your seat will be held for 15 minutes after the start of the course; after that, those without tickets will be seated according to space availability. When the room is filled, no additional people will be admitted due to fire department regulations. If you have not pre-registered, please be prepared to select an alternate session to attend.

Tickets
Tickets are required for all courses excluding Live Dentistry. Tickets for all functions can be purchased at all general registration booths located in the Registration Area on the Upper Level in the Crystal Palace and online.

6 Days of Education Seminars, Hands-on Workshops & Essays
Friday - Wednesday
4 Days of Exhibits
Sunday - Wednesday

FREE "Live" Dentistry
Hi-Tech 450 Seat Arena

SUNDAY
9:45 - 11:45
VOCO America, Inc.
(Drs. Ron Kaminer & Marc Geissberger)
9:45 - 11:45
Shofu
(Drs. Ron Kaminer)

MONDAY
1:30 - 2:45
Philips Sonicare
(Dr. Gerard Kugel)
3:30 - 5:15
3Shape
(Dr. Sundeep Rawal)

TUESDAY
2:00 - 4:15
GlideWell
(Dr. Justin Chi)

WEDNESDAY
2:00 - 4:15
Benco / Vatech
(Dr. Aeklavya Panjali)

Celebrity Luncheon Speaker
John Quiñones
Monday, December 2nd
12:00 - 2:00 - Ticket 4010
$125.00

3D Printing & Digital Dentistry Conference

Dental Laboratory Technicians Programs
Sleep Apnea Symposium
Oral Cancer Symposium

WORLD IMPLANT EXPO
5th Annual Global Orthodontic Conference
3rd Annual Pediatric Dentistry Summit
12th Annual INVISALIGN® - GNYDM EXPO
4 Days of Programming:
Sunday - Wednesday

Botox and Facial Fillers Seminar & Workshop
Over 1,700 Exhibit Booths
## Emergency and Follow-Up Management of the Avulsed (Knocked-Out) Tooth

<table>
<thead>
<tr>
<th>On-Site</th>
<th>Emergency Facility</th>
<th>Under 10 years of age—permanent teeth with open apex</th>
<th>10 years of age or older—permanent teeth with closed apex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On-Site</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Replant Tooth</strong></td>
<td><strong>Unable to Replant</strong></td>
<td><strong>Unable to Replant</strong></td>
<td><strong>Replant Tooth</strong></td>
</tr>
<tr>
<td>Rinse gently to remove foreign objects from tooth</td>
<td>Place in transport media</td>
<td>Transport media not used</td>
<td>Rinse gently to remove foreign objects from tooth</td>
</tr>
<tr>
<td></td>
<td><em>a.</em> special storage media</td>
<td><em>Dry time greater than 1 hour</em></td>
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</tr>
<tr>
<td></td>
<td><em>b.</em> milk</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>c.</em> saline</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>d.</em> saliva</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Dry time less than 1 hour</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Emergency Facility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Antibiotics</strong></td>
<td><strong>Antibiotics</strong></td>
<td></td>
<td><strong>Antibiotics</strong></td>
</tr>
<tr>
<td><em>a.</em> Penicillin—1000 mg stat and 500 mg every 6 hours for 7 days</td>
<td><em>use appropriate doses for patient age and weight</em></td>
<td><em>Penicillin—every 6 hours for 7 days</em></td>
<td></td>
</tr>
<tr>
<td><em>b.</em> Doxycycline—100 mg every 12 hours for 7 days for patients not susceptible to tetracycline staining</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tetanus booster as needed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Patient Instruction:</strong> 1. Soft diet; 2. Brush with soft toothbrush after each meal; 3. Rinse with 0.12% chlorhexidine every 12 hours for 1 week</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>7-10 Days</strong></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td><strong>Remove flexible splint</strong></td>
<td><strong>If revascularization is a possibility, avoid endodontic treatment unless obvious signs of nonhealing are present; sensitivity may take 3 months to respond positively; if endodontic treatment is necessary, follow guidelines for teeth with closed apices until apexification is completed; obturate with gutta-percha</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Remove pulp</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Place dental calcium hydroxide paste</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>30 Days</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Obturate with gutta-percha if lamina dura intact:</strong> If root resorption present, replace Ca(OH)(_2) —evaluate and change Ca(OH)(_2) every 3 months; then obturate with gutta-percha if lamina dura intact</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6 Months</strong></td>
<td><strong>Clinical and radiographic exam (post-obturation)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1 Year</strong></td>
<td><strong>Clinical and radiographic exam (follow-up for 5 years)</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Emergency and Follow-Up Management of Other Dental Alveolar Injuries

<table>
<thead>
<tr>
<th>Diagnosis/Clinical Findings</th>
<th>Concussion</th>
<th>Subluxation</th>
<th>Extrusion</th>
<th>Lateral Luxation</th>
<th>Intrusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tooth tender to touch; no displacement; no mobility</td>
<td>Tooth tender to touch and mobile; bleeding from gums</td>
<td>Tooth partially protruding from bone/jaw</td>
<td>Tooth displaced axially from normal position; often tender to touch or mobile—possibly locked into bone (high metallic sound upon percussion)</td>
<td>Tooth is displaced deeper into the bone/jaw; high metallic sound upon percussion</td>
<td></td>
</tr>
<tr>
<td>Radiographic/Clinical Assessment and Findings</td>
<td>Radiographs; evaluate pulp chamber size and root development; sensitivity testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Palliative; flexible splint (7-10 days) for comfort if needed</td>
<td>Reposition; flexible splint</td>
<td>Reposition into normal position; the tooth often must be extruded occclusally past the bony lock prior to repositioning; evaluate position with radiographs; flexible splint</td>
<td>Slightly luxate with forceps; with incomplete root formation, allow for spontaneous re-eruption; teeth with complete root formation, orthodontic or surgical repositioning</td>
<td></td>
</tr>
<tr>
<td>Patient Instruction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 3 Weeks</td>
<td>Splint removal; clinical/radiographic exam; sensitivity testing</td>
<td>Splint removal; in case of radiographic marginal bone breakdown, add 5-4 weeks to splint time; clinical and radiographic exam</td>
<td>Initiate root canal treatment in 1-3 weeks; splint removal except in teeth with open apices that erupt spontaneously</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagnosis/Clinical Findings</th>
<th>Crown Fracture</th>
<th>Crown-Root Fracture</th>
<th>Root Fracture</th>
<th>Alveolar Fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncomplicated</td>
<td>Enamel or enamel-dentin fracture</td>
<td>Enamel-dentin fracture; pulp exposed</td>
<td>Crown attached to gingiva and mobile; pulp may or may not be exposed</td>
<td>Crown usually mobile and sometimes displaced</td>
</tr>
<tr>
<td>Complicated</td>
<td>Enamel-dentin fracture; pulp exposed</td>
<td></td>
<td>Crown attached to gingiva and mobile; pulp may or may not be exposed</td>
<td>Crown usually mobile and sometimes displaced</td>
</tr>
</tbody>
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<tr>
<th>Radiographic/Clinical Assessment and Findings</th>
<th>Radiographs; evaluate pulp chamber size and root development; sensitivity testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Cover dentin, a, glass ionomer (temporary); b, composite resin; c, bond fragment; consider Ca(OH), if close to the pulp</td>
</tr>
<tr>
<td>Emergency—stabilize coronal fragment with acid etch/resin splint; definitive treatment—expose subgingival fracture site by: a. gingivectomy; b, orthodontic or surgical extrusion; Immature tooth: vital pulp therapy; Mature tooth: root canal treatment</td>
<td>Reposition coronal fragment; flexible splint, 3-4 weeks</td>
</tr>
<tr>
<td>Reposition fragment; splint, 3-4 weeks</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient Instruction</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>3-4 Weeks</td>
<td>Splint removal; clinical and radiographic exam; sensitivity testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-8 Weeks</td>
<td>Clinical and radiographic exam, including sensitivity testing; further follow-up at 6 months, 1 year, and annually for 5 years</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 either 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.

The contribution of the Canadian Academy of Endodontics and others to the development of this form is gratefully acknowledged.

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**AEE Endodontic Case Difficulty Assessment Form**

<table>
<thead>
<tr>
<th>A. PATIENT CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDICAL HISTORY</td>
</tr>
<tr>
<td>□ No medical problem</td>
</tr>
<tr>
<td>□ One or more medical problems (ASA Class 1*)</td>
</tr>
<tr>
<td>□ Complex medical history/medical illness/disability (ASA Class 2*)</td>
</tr>
</tbody>
</table>

| ANESTHESIA               |
| □ No history of anesthesia problems |
| □ Vasoconstrictor intolerance |
| □ Difficulty achieving anesthesia |

| PATIENT DISPOSITION       |
| □ Cooperative and compliant |
| □ Ambivalent but cooperative |

| ABILITY TO OPEN MOUTH     |
| □ No limitation            |
| □ Slight limitation opening |
| □ Significant limitation 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  |

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**B. DIAGNOSTIC AND TREATMENT CONSIDERATIONS**

**DIAGNOSIS**

□ Signs and symptoms consistent with recognized pulp 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 key palatal vault, presence of torti)

□ Extreme difficulty obtaining/interpreting radiographs (e.g., superimposed anatomic structures)

□ Extensive difficulty obtaining/interpreting radiographs

**POSITION IN THE ARCH**

□ Anterior/premolar

□ Slope inclination (<10°)

□ Slope inclination (10-30°)

□ Extreme inclination (>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

□ Extreme deviation from normal tooth/root form (e.g., fusion, dens in dente)

**CANAL AND ROOT MORPHOLOGY**

□ Sloit or no canal (<1 mm in diameter)

□ Canal(s) visible and reduced in size

□ Canal(s) and chamber visible but reduced in size

□ Open apex (<1.5 mm in diameter)

**RESECTION**

□ No resection evident

□ Extensive apical resection

□ Internal resection

□ External resection

---

**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

□ Axial fracture

□ Intrusive, extrusive or lateral laceration

□ 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

□ Concomitant moderate periodontal disease

□ Concomitant severe periodontal disease

□ Cracked teeth with periodontal complications

□ Combined endodontic/periodontic lesion

□ Root amputation prior to endodontic treatment

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*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 systemic illness which limits activity, 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.ana.org/link/physicalstatus.htm
Use of Cone Beam Computed Tomography in Endodontics

2015 Update

INTRODUCTION

This updated joint position statement of the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology is intended to provide scientifically based guidance to clinicians regarding the use of cone beam computed tomography in endodontic treatment and reflects new developments since the 2010 statement (1). The guidance in this statement is not intended to substitute for a clinician’s independent judgment in light of the conditions and needs of a specific patient.

Endodontic disease adversely affects quality of life and can produce significant morbidity in afflicted patients. Radiography is essential for the successful diagnosis of odontogenic and nonodontogenic pathoses, treatment of the root canal systems of a compromised tooth, biomechanical instrumentation, evaluation of final canal obturation and assessment of healing.

Until recently, radiographic assessments in endodontic treatment were limited to intraoral and panoramic radiography. These radiographic technologies provide two-dimensional representations of three-dimensional anatomic structures. If any element of the geometric configuration is compromised, the image may demonstrate errors (2). In more complex cases, radiographic projections with different beam angulations can allow parallax localization. However, complex anatomy and surrounding structures can render interpretation of planar images difficult.

The advent of CBCT has made it possible to visualize the dentition, the maxillofacial skeleton, and the relationship of anatomic structures in three dimensions (3). CBCT, as with any technology, has known limitations, including a possible higher radiation dose to the patient. Other limitations include potential for artifact generation, high levels of scatter and noise and variations in dose distribution within a volume of interest (4).

CBCT should be used only when the patient’s history and a clinical examination demonstrate that the benefits to the patient outweigh the potential risks. CBCT should not be used routinely for endodontic diagnosis or for screening purposes in the absence of clinical signs and symptoms. Clinicians should use CBCT only when the need for imaging cannot be met by lower-dose two-dimensional radiography.

Volume Size(s)/Field of View

There are numerous CBCT equipment manufacturers, and several models are available. In general, CBCT is categorized into large, medium and limited-volume units based on the size of their “field of view.” The size of the FOV describes the scan volume of CBCT machines. That volume determines the extent of anatomy included. It is dependent on the detector size and shape, beam projection geometry and the ability to collimate the beam. To the extent practical, FOV should only slightly exceed the dimensions of the anatomy of interest.

Generally, the smaller the FOV, the lower the dose associated with the study. Beam collimation limits the radiation exposure to the region of interest and helps ensure that an optimal FOV can be selected based on disease presentation.
Smaller scan volumes generally produce higher-resolution images. Because endodontics relies on detecting small alterations such as disruptions in the periodontal ligament space, optimal resolution should be sought (5).

The principal limitations of large FOV CBCT imaging are the size of the field irradiated and the reduced resolution compared to intraoral radiographs and limited-volume CBCT units with inherent small voxel sizes (5). The smaller the voxel size, the higher the spatial resolution. Moreover, the overall scatter generated is reduced due to the limited size of the FOV. Optimization of the exposure protocols keeps doses to a minimum without compromising image quality. If a low-dose protocol can be used for a diagnostic task that requires lower resolution, it should be employed, absent strong indications to the contrary.

In endodontics, the area of interest is limited and determined prior to imaging. For most endodontic applications, limited FOV CBCT is preferred to medium or large FOV CBCT because there is less radiation dose to the patient, higher spatial resolution and shorter volumes to be interpreted.

Dose Considerations

Selection of the most appropriate imaging protocol for the diagnostic task must be consistent with the ALARA principles that every effort should be made to reduce the effective radiation dose to the patient “as low as reasonably achievable.” Because radiation dose for a CBCT study is higher than that for an intraoral radiograph, clinicians must consider overall radiation dose over time. For example, will acquiring a CBCT study now eliminate the need for additional imaging procedures in the future? It is recommended to use the smallest possible FOV, the smallest voxel size, the lowest mA setting (depending on the patient's size) and the shortest exposure time in conjunction with a pulsed exposure-mode of acquisition.

If extension of pathoses beyond the area surrounding the tooth apices or a multifocal lesion with possible systemic etiology is suspected, and/or a nonendodontic cause for devitalization of the tooth is established clinically, appropriate larger field of view protocols may be employed on a case-by-case basis.

There is a special concern with overexposure of children (up to and including 18 years of age) to radiation, especially with the increased use of CT scans in medicine. The AAE and the AAOMR support the Image Gently Campaign led by the Alliance for Radiation Safety in Pediatric Imaging. The goal of the campaign is “to change practice; to raise awareness of the opportunities to lower radiation dose in the imaging of children.” Information on use of CT is available at www.imagegently.org/Procedures/ComputedTomography.aspx.

Interpretation

If a clinician has a question regarding image interpretation, it should be referred to an oral and maxillofacial radiologist (6).

RECOMMENDATIONS

The following recommendations are for limited FOV CBCT scans.

Diagnosis

Endodontic diagnosis is dependent upon thorough evaluation of the patient’s chief complaint, history and clinical and radiographic examination. Preoperative radiographs are an essential part of the diagnostic phase of endodontic therapy. Accurate diagnostic imaging supports the clinical diagnosis.

Recommendation 1: Intraoral radiographs should be considered the imaging modality of choice in the evaluation of the endodontic patient.

Recommendation 2: Limited FOV CBCT should be considered the imaging modality of choice for diagnosis in patients who present with contradictory or nonspecific clinical signs and symptoms associated with untreated or previously endodontically treated teeth.
Rationale:

- In some cases, the clinical and planar radiographic examinations are inconclusive. Inability to confidently determine the etiology of endodontic pathosis may be attributed to limitations in both clinical vitality testing and intraoral radiographs to detect odontogenic pathoses. CBCT imaging has the ability to detect periapical pathosis before it is apparent on 2-D radiographs (7).
- Preoperative factors such as the presence and true size of a periapical lesion play an important role in endodontic treatment outcome. Success, when measured by radiographic criteria, is higher when teeth are endodontically treated before radiographic signs of periapical disease are detected (8).
- Previous findings have been validated in clinical studies in which primary endodontic disease detected with intraoral radiographs and CBCT was 20% and 48%, respectively. Several clinical studies had similar findings, although with slightly different percentages (9,10). *Ex vivo* experiments in which simulated periapical lesions were created yielded similar results (11,12). Results of *in vivo* animal studies, using histologic assessments as the gold standard, also showed similar results observed in human clinical and *ex vivo* studies (13).
- Persistent intraoral pain following root canal therapy often presents a diagnostic challenge. An example is persistent dentoalveolar pain also known as atypical odontalgia (14). The diagnostic yield of conventional intraoral radiographs and CBCT scans was evaluated in the differentiation between patients presenting with suspected atypical odontalgia versus symptomatic apical periodontitis, without radiographic evidence of periapical bone destruction (15). CBCT imaging detected 17% more teeth with periapical bone loss than conventional radiography.

Initial Treatment

Preoperative

**Recommendation 3:** Limited FOV CBCT should be considered the imaging modality of choice for initial treatment of teeth with the potential for extra canals and suspected complex morphology, such as mandibular anterior teeth, and maxillary and mandibular premolars and molars, and dental anomalies.

Intraoperative

**Recommendation 4:** If a preoperative CBCT has not been taken, limited FOV CBCT should be considered as the imaging modality of choice for intra-appointment identification and localization of calcified canals.

Postoperative

**Recommendation 5:** Intraoral radiographs should be considered the imaging modality of choice for immediate postoperative imaging.

Rationale:

- Anatomical variations exist among different types of teeth. The success of nonsurgical root canal therapy depends on identification of canals, cleaning, shaping and obturation of root canal systems, as well as quality of the final restoration.
- 2-D imaging does not consistently reveal the actual number of roots and canals. In studies, data acquired by CBCT showed a very strong correlation between sectioning and histologic examination (16,17).
- In a 2013 study, CBCT showed higher mean values of specificity and sensitivity when compared to intraoral radiographic assessments in the detection of the MB2 canal (18).

Nonsurgical Retreatment

**Recommendation 6:** Limited FOV CBCT should be considered the imaging modality of choice if clinical examination and 2-D intraoral radiography are inconclusive in the detection of vertical root fracture.
Rationale:

• In nonsurgical retreatment, the presence of a vertical root fracture significantly decreases prognosis. In the majority of cases, the indication of a vertical root fracture is more often due to the specific pattern of bone loss and periodontal ligament space enlargement than direct visualization of the fracture. CBCT may be recommended for the diagnosis of vertical root fracture in unrestored teeth when clinical signs and symptoms exist.

• Higher sensitivity and specificity were observed in a clinical study where the definitive diagnosis of vertical root fracture was confirmed at the time of surgery to validate CBCT findings, with sensitivity being 88% and specificity 75% (19). Several case series studies have concluded that CBCT is a useful tool for the diagnosis of vertical root fractures. In vivo and laboratory studies (20, 21) evaluating CBCT in the detection of vertical root fractures agreed that sensitivity, specificity, and accuracy of CBCT were generally higher and reproducible. The detection of fractures was significantly higher for all CBCT systems when compared to intraoral radiographs. However, these results should be interpreted with caution because detection of vertical root fracture is dependent on the size of the fracture, presence of artifacts caused by obturation materials and posts and the spatial resolution of the CBCT.

Recommendation 7: Limited FOV CBCT should be the imaging modality of choice when evaluating the nonhealing of previous endodontic treatment to help determine the need for further treatment, such as nonsurgical, surgical or extraction.

Recommendation 8: Limited FOV CBCT should be the imaging modality of choice for nonsurgical retreatment to assess endodontic treatment complications, such as overextended root canal obturation material, separated endodontic instruments, and localization of perforations.

Rationale:

• It is important to evaluate the factors that impact the outcome of root canal treatment. The outcome predictors identified with periapical radiographs and CBCT were evaluated by Liang et al. (22) The results showed that periapical radiographs detected periapical lesions in 18 roots (12%) as compared to 37 on CBCT scans (25%). Eighty percent of apparently short root fillings based on intraoral radiographs images appeared flush on CBCT. Treatment outcome, length and density of root fillings and outcome predictors determined by CBCT showed different values when compared with intraoral radiographs.

• Accurate treatment planning is an essential part of endodontic retreatment. Incorrect, delayed or inadequate endodontic diagnosis and treatment planning places the patient at risk and may result in unnecessary treatment. Treatment planning decisions using CBCT versus intraoral radiographs were compared to the gold standard diagnosis (23). An accurate diagnosis was reached in 36%-40% of the cases with intraoral radiographs compared to 76%-83% with CBCT. A high level of misdiagnosis was noted in invasive cervical resorption and vertical root fracture. In this study, the examiners altered their treatment plan after reviewing the CBCT in 56%-62.2% of the cases, thus indicating the significant influence of CBCT.

Surgical Retreatment

Recommendation 9: Limited FOV CBCT should be considered as the imaging modality of choice for presurgical treatment planning to localize root apex/apices and to evaluate the proximity to adjacent anatomical structures.

Rationale:

The use of CBCT has been recommended for treatment planning of endodontic surgery (24, 25). CBCT visualization of the true extent of periapical lesions and their proximity to important vital structures and anatomical landmarks is superior to that of periapical radiographs.

Special Conditions

Implant placement

Recommendation 10: Limited FOV CBCT should be considered as the imaging modality of choice for surgical placement of implants (26).
Traumatic injuries

Recommendation 11: Limited FOV CBCT should be considered the imaging modality of choice for diagnosis and management of limited dento-alveolar trauma, root fractures, luxation, and/or displacement of teeth and localized alveolar fractures, in the absence of other maxillofacial or soft tissue injury that may require other advanced imaging modalities (27).

Resorptive defects

Recommendation 12: Limited FOV CBCT is the imaging modality of choice in the localization and differentiation of external and internal resorptive defects and the determination of appropriate treatment and prognosis (28, 29).
REFERENCES


Thank you to the Special Committee to Revise the Joint AAE/AAOMR Position Statement on Cone Beam-Computed Tomography:

Mohamed I. Fayad, Co-Chair, AAE
Martin D. Levin, AAE
Richard A. Rubinstein, AAE
Craig S. Hirschberg, AAE Board Liaison

Madhu K. Nair, Co-Chair, AAOMR
Erika Benavides, AAOMR
Sevin Barghan, AAOMR
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## Problem-Solving Flowchart

### PROBLEM: Unable to observe the pulp chamber floor due to excessive bleeding

**Cause**
- This is usually caused by pulp tissue either in the chamber or in the canals

**Remedy**
- Enlarge the access by removing the pulp chamber roof without touching the chamber floor (Never touch the pulp chamber floor unless the floor-wall junction is fully seen)
- Place hemostatic agents in the chamber
- Use a barbed broach to remove the tissue

### PROBLEM: Calcification/pulp stones

**Cause**
- Degenerating pulp

**Remedy**
- Following the complete removal of the pulp chamber roof and cessation of bleeding, a large smooth round bur (#6) can be used to smooth the pulp chamber floor to remove the calcification and delineate the floor-wall junction clearly

### PROBLEM: Unable to observe the pulp chamber floor due to inadequate removal of pulp chamber roof

**Cause**
- Improper selection of the initial access penetration point
- Inability to see the floor-wall junction 360 degrees around

**Remedy**
- Return to previous bur (either round or tapered) and continue to shave back until the floor-wall junction is visualized

### PROBLEM: Unable to observe the pulp chamber floor due to inadequate light

**Cause**
- Access too small
- Presence of crowns or restorative materials
- Lack of smooth surfaces of walls or pulp chamber floor (usually caused by too small round burs)

**Remedy**
- Enlarge access until floor-wall junction can be seen
- Remove restorative materials
- Use accessory light (LED headlight or surgical operating microscope) when crown is present
- Smooth all irregularities on walls and pulp chamber floor with round burs

### PROBLEM: Unable to observe the pulp chamber floor due to restorative materials impinging onto the pulp chamber

**Cause**
- Inadequate removal of all restorative material before access has begun (in particular, Class V restoration may impinge onto the pulp chamber floor)

**Remedy**
- Remove all restorative material before beginning the access

### PROBLEM: Unable to observe the pulp chamber floor due to loss of orientation

**Cause**
- Using occlusal surface as reference point
- Failure to observe tooth orientation such as rotated or tilted tooth
- Losing sight of CEJ circumference
- Improper angulation of initial access

**Remedy**
- Proper pre-access observation of tooth orientation
- Proper mental imaging of the CEJ
- Remove rubber dam during access to regain orientation
- Appropriate angle of penetration of initial access bur
**PROBLEM: Floor perforation**

**Cause**
- Premature attempt to identify orifices
- Failing to measure occlusal-furcal distance
- Improper identification of the floor-wall junction
- Inadequate access

**Remedy**
- Remove entire pulp chamber roof before identifying orifice location
- Observe floor-wall junction 360 degrees around
- Set bur at length less than occluso-furcal distance
- Direct accessing bur towards center of the CEJ perimeter

**PROBLEM: Unable to identify all orifices**

**Cause**
- Failure to establish a complete access
- Lack of delineation of a distinct floor-wall junction
- Presence of restorative materials
- Presence of calcifications

**Remedy**
- Make sure a complete access is performed
- Smooth the pulp chamber floor to remove calcifications and delineate floor-wall junction
- Use laws of pulp chamber floor anatomy to identify the positions of orifices

**PROBLEM: Lateral chamber wall perforation**

**Cause**
- Failing to mentally image the CEJ
- Improper angle of access entry
- Using occlusal anatomy to begin access penetration

**Remedy**
- Remove entire pulp chamber roof before identifying orifice location
- Observe floor-wall junction 360 degrees around
- Direct accessing bur towards center of the CEJ perimeter
- Choose initial penetrating access point based on CEJ imaged perimeter

**Summary**

In order to increase the success rate of endodontically treated teeth, as much of the pulp complex should be removed as is possible. In order to accomplish this, all of the root canal orifices in a pulp chamber must be found. The only rational way to do this is by utilizing the laws of anatomy of the pulp chamber floor. The only way to utilize these laws is by having an access that permits the visualization of the pulp chamber walls meeting the floor 360 degrees around. This newsletter has demonstrated and provided solutions to all of the clinical conditions that may hinder this visualization. In addition, we have presented a problem-solving flowchart that addresses all of the common pitfalls during access and orifice location that may confront a general practitioner.