IMAGING SERVICES: CONE BEAM COMPUTED TOMOGRAPHY

Policy Number: DCP002.02

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INSTRUCTIONS FOR USE

This Dental Coverage Policy provides assistance in interpreting UnitedHealthcare dental benefit plans. When deciding coverage, the member specific benefit plan document must be referenced. The terms of the member specific benefit plan document [e.g., Certificate of Coverage (COC), Schedule of Benefits (SOB), and/or Summary Plan Description (SPD)] may differ greatly from the standard benefit plan upon which this Dental Coverage Policy is based. In the event of a conflict, the member specific benefit plan document supersedes this Dental Coverage Policy. All reviewers must first identify member eligibility, any federal or state regulatory requirements, and the member specific benefit plan coverage prior to use of this Dental Coverage Policy. Other Clinical Policies and Coverage Guidelines may apply.

UnitedHealthcare reserves the right, in its sole discretion, to modify its Policies and Guidelines as necessary. This Dental Coverage Policy is provided for informational purposes. It does not constitute medical advice.

BENEFIT CONSIDERATIONS

Before using this policy, please check the member specific benefit plan document and any federal or state mandates, if applicable.

Essential Health Benefits for Individual and Small Group

For plan years beginning on or after January 1, 2014, the Affordable Care Act of 2010 (ACA) requires fully insured non-grandfathered individual and small group health plans (inside and outside of Exchanges) to provide coverage for Pediatric Dental Essential Health Benefits ("EHBs"). Large group plans (both self-funded and fully insured), and small group ASO plans, are not subject to the requirement to offer coverage for Pediatric Dental EHBs. However, if such plans choose to provide coverage for benefits which are deemed Pediatric Dental EHBs, the ACA requires all dollar limits on those benefits to be removed on all Grandfathered and Non-Grandfathered plans. The determination of which benefits constitute Pediatric Dental EHBs is made on a state by state basis. As such, when using this policy, it is important to refer to the member specific benefit plan document to determine benefit coverage.

COVERAGE RATIONALE

Cone beam computed tomography (CBCT) is unproven and not medically necessary for routine dental applications.

There is insufficient evidence that CBCT is beneficial for use in routine dental applications. CBCT should not replace traditional dental x-rays as a preliminary diagnostic tool, or for routine dental procedures such as restorations, but be used as an adjunct when the level of detail CBCT is needed to safely render treatment for complex clinical conditions (e.g., oral surgery, implant placement and endodontics). These procedures may have a higher risk of complications without the level of detail CBCT imaging provides. CBCT imaging used for these reasons should be read and interpreted by an appropriately trained professional.
In addition, radiation exposure associated with CBCT needs to be weighed against possible benefits, which have not been supported in the published literature. Limited definitive conclusions regarding the clinical role of CBCT can be reached due to the lack of well-designed studies that systematically evaluate diagnostic accuracy and the impact of CBCT on clinical decision making and patient health outcomes. Additional studies are needed to verify that CBCT provides added diagnostic value beyond two-dimensional imaging such as panoramic radiography and conventional computed tomography and to determine whether CBCT improves treatment decision making and health outcomes.

**DEFINITIONS**

**Cone beam computed tomography (CBCT):** An x-ray machine that produces a three dimensional (3-D) image of dental structures, soft tissues, nerve pathways and bone of the craniofacial region in a single scan.

**APPLICABLE CODES**

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this policy does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by the member specific benefit plan document and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other Clinical Policies and Coverage Guidelines may apply.

### CDT Code Table

<table>
<thead>
<tr>
<th>CDT Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>D0364</td>
<td>cone beam CT capture and interpretation with limited field of view – less than one whole jaw</td>
</tr>
<tr>
<td>D0365</td>
<td>cone beam CT capture and interpretation with field of view of one full dental arch – mandible</td>
</tr>
<tr>
<td>D0366</td>
<td>cone beam CT capture and interpretation with field of view of one full dental arch – maxilla, with or without cranium</td>
</tr>
<tr>
<td>D0367</td>
<td>cone beam CT capture and interpretation with field of view of both jaws, with or without cranium</td>
</tr>
<tr>
<td>D0368</td>
<td>cone beam CT capture and interpretation for TMJ series including two or more exposures</td>
</tr>
<tr>
<td>D0380</td>
<td>cone beam CT image capture with limited field of view – less than one whole jaw</td>
</tr>
<tr>
<td>D0381</td>
<td>cone beam CT image capture with field of view of one full dental arch – mandible</td>
</tr>
<tr>
<td>D0382</td>
<td>cone beam CT image capture with field of view of one full dental arch – maxilla, with or without cranium</td>
</tr>
<tr>
<td>D0383</td>
<td>cone beam CT image capture with field of view of both jaws, with or without cranium</td>
</tr>
<tr>
<td>D0384</td>
<td>cone beam CT image capture for TMJ series including two or more exposures</td>
</tr>
<tr>
<td>D0391</td>
<td>interpretation of diagnostic image by a practitioner not associated with capture of the image, including report</td>
</tr>
<tr>
<td>D0393</td>
<td>treatment simulation using 3D image volume</td>
</tr>
<tr>
<td>D0394</td>
<td>digital subtraction of two or more images or image volumes of the same modality</td>
</tr>
<tr>
<td>D0395</td>
<td>fusion of two or more 3D image volumes of one or more modalities</td>
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*CDT® is a registered trademark of the American Dental Association*

### CPT Code Table

<table>
<thead>
<tr>
<th>CPT Code</th>
<th>Description</th>
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<tr>
<td>70486*</td>
<td>Computed tomography, maxillofacial area; without contrast material</td>
</tr>
<tr>
<td>70487*</td>
<td>Computed tomography, maxillofacial area; with contrast material(s)</td>
</tr>
<tr>
<td>70488*</td>
<td>Computed tomography, maxillofacial area; without contrast material, followed by contrast material(s) and further sections</td>
</tr>
<tr>
<td>76376*</td>
<td>3D rendering with interpretation and reporting of computed tomography, magnetic resonance imaging, ultrasound, or other tomographic modality with image postprocessing under concurrent supervision; not requiring image postprocessing on an independent workstation</td>
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UnitedHealthcare Dental Clinical Policy
**Proprietary Information of UnitedHealthcare. Copyright 2017 United HealthCare Services, Inc.**
**CPT Code** | **Description**
---|---
76377* | 3D rendering with interpretation and reporting of computed tomography, magnetic resonance imaging, ultrasound, or other tomographic modality with image postprocessing under concurrent supervision; requiring image postprocessing on an independent workstation

*Coding Clarification:* Dentists submitting claims for cone beam computed tomography using the above CPT codes will be subject to medical guidelines and procedures. See the following for additional information: Physician Guidelines: Current, Evidence-based Recommendations Regarding Imaging.

**DESCRIPTION OF SERVICES**

Cone-beam computed tomography (CBCT) is a variation of traditional computed tomography (CT). The CBCT systems used by dental professionals rotate around the patient, capturing data using a cone-shaped X-ray beam. These data are used to reconstruct a three-dimensional (3D) image of the patient’s oral and maxillofacial region. Dental CBCT are increasingly used by radiologists and dental professionals for various clinical applications including dental implant planning, visualization of abnormal teeth, endodontic (root canal) diagnosis, and diagnosis of dental trauma. Although the radiation doses from dental CBCT exams are generally lower than other CT exams, dental CBCT exams typically deliver more radiation than conventional dental X-ray exams. Concerns about radiation exposure are greater for younger patients because they are more sensitive to radiation (i.e., estimates of their lifetime risk for cancer incidence and mortality per unit dose of ionizing radiation are higher) and they have a longer lifetime for ill effects to develop. See the following Web site for additional information: [http://www.fda.gov/Radiation EmittingProducts/RadiationEmittingProductsandProcedures/MedicalImaging/MedicalX-Rays/ucm315011.htm](http://www.fda.gov/Radiation EmittingProducts/RadiationEmittingProductsandProcedures/MedicalImaging/MedicalX-Rays/ucm315011.htm). (Accessed September 14, 2016)

**CLINICAL EVIDENCE**

The European Commission (EC), in an evidence based report prepared by the SEDENTEXCT project (Safety and Efficacy of a New and Emerging Dental X-Ray Modality) for Cone Beam CT for Dental and Maxillofacial Radiology, recommends that all CBCT examinations be justified on an individual basis by demonstrating that any potential patient benefits outweigh the potential risks and would add new information to aid patient management (SEDENTEXCT 2012).

The report included the following recommendations:

- For the localized assessment of an impacted tooth (including consideration of resorption of an adjacent tooth) where the current imaging method of choice is multi-slice computer tomography (MSCT), CBCT may be preferred because of reduced radiation dose. Evidence grading: GP
- CBCT may be indicated for the localized assessment of an impacted tooth (including consideration of resorption of an adjacent tooth) where the current imaging method of choice is conventional dental radiography and when the information cannot be obtained adequately by lower dose conventional (traditional) radiography. Evidence grading: C
- For the localized assessment of an impacted tooth (including consideration of resorption of an adjacent tooth), the smallest volume size compatible with the situation should be selected because of reduced radiation dose. The use of CBCT units offering only large volumes (craniofacial CBCT) requires very careful justification and is generally discouraged. Evidence grading: GP
- CBCT is not normally indicated for planning the placement of temporary anchorage devices in orthodontics. Evidence grading: GP
- Large volume CBCT should not be used routinely for orthodontic diagnosis. Evidence grading: D
- For complex cases of skeletal abnormality, particularly those requiring combined orthodontic/surgical management, large volume CBCT may be justified in planning the definitive procedure, particularly where MSCT is the current imaging method of choice. Evidence grading: GP
- CBCT is not indicated as a method of caries detection and diagnosis. Evidence grading: B
- CBCT is not indicated as a routine method of imaging periodontal bone support. Evidence grading: C
- Limited volume, high resolution CBCT may be indicated in selected cases of infra-bony defects and furcation lesions, where clinical and conventional radiographic examinations do not provide the information needed for
management.
Evidence grading: C

- CBCT is not indicated as a standard method for identification of periapical pathosis.
Evidence grading: GP
- Limited volume, high resolution CBCT may be indicated for periapical assessment, in selected cases, when conventional radiographs give a negative finding when there are contradictory positive clinical signs and symptoms.
Evidence grading: GP
- CBCT is not indicated as a standard method for demonstration of root canal anatomy.
Evidence grading: GP
- Limited volume, high resolution CBCT may be indicated, for selected cases where conventional intraoral radiographs provide information on root canal anatomy which is equivocal or inadequate for planning treatment, most probably in multi-rooted teeth.
Evidence grading: GP
- Limited volume, high resolution CBCT may be indicated for selected cases when planning surgical endodontic procedures. The decision should be based upon potential complicating factors, such as the proximity of important anatomical structures.
Evidence grading: GP
- Limited volume, high resolution CBCT may be indicated in selected cases of suspected, or established, inflammatory root resorption or internal resorption, where three-dimensional information is likely to alter the management or prognosis of the tooth.
Evidence grading: D
- Limited volume, high resolution CBCT may be justifiable for selected cases, where endodontic treatment is complicated by concurrent factors, such as resorption lesions, combined periodontal/endodontic lesions, perforations and atypical pulp anatomy.
Evidence grading: C
- Limited volume, high resolution CBCT is indicated in the assessment of dental trauma (suspected root fracture) in selected cases, where conventional intraoral radiographs provide inadequate information for treatment planning. The studies used for the review by SEDENTEXCT included 8 publications, seven of which were laboratory studies using extracted teeth and the other an in vivo animal study.
Evidence grading: B
- Where conventional radiographs suggest a direct inter-relationship between a mandibular third molar and the mandibular canal, and when a decision to perform surgical removal has been made, CBCT may be indicated.
Evidence grading: C
- CBCT may be indicated for pre-surgical assessment of an unerupted tooth in selected cases where conventional radiographs fail to provide the information required.
Evidence grading: GP
- CBCT is indicated for cross-sectional imaging prior to implant placement as an alternative to existing cross-sectional techniques where the radiation dose of CBCT is shown to be lower.
Evidence grading: D
- For cross-sectional imaging prior to implant placement, the advantage of CBCT with adjustable fields of view, compared with MSCT, becomes greater where the region of interest is a localized part of the jaws, as a similar sized field of view can be used.
Evidence grading: GP
- Where it is likely that evaluation of soft tissues will be required as part of the patient’s radiological assessment, the appropriate initial imaging should be MSCT or MR, rather than CBCT. Evidence grading: BP - statement was identical to, or directly derived from, a "Basic Principle" of use of dental CBCT, as developed by consensus of the European Academy of Dental and Maxillofacial Radiology (Horner, 2009)

Grading systems used for the above levels of evidence were adapted from Scottish Intercollegiate Guidelines Network (SIGN), and can be found at: [http://www.sign.ac.uk/guidelines/fulltext/50/annexoldb.html](http://www.sign.ac.uk/guidelines/fulltext/50/annexoldb.html) and [http://www.sedentexct.eu/files/guidelines_final.pdf](http://www.sedentexct.eu/files/guidelines_final.pdf). (Accessed September 15, 2016)

**Endodontics**

Long et al. (2014) conducted a meta-analysis to determine the diagnostic accuracy of cone-beam computed tomography (CBCT) for tooth fractures in vivo. A total of 12 studies were included in the meta-analysis. The pooled sensitivity, specificity, positive likelihood ratio, negative likelihood ratio and summary receiver operating characteristic were 0.92, 0.85, 5.68, 0.13 and 0.94, respectively. The pooled prevalence of tooth fractures in patients with clinically-suspected but periapical-radiography-undetected tooth fractures was 91%. Positive and negative predictive values were 0.98 and 0.43. The authors concluded that CBCT has a high diagnostic accuracy for tooth fractures and could be used in clinical settings. The authors stated that they were very confident with positive test results but negative test results should be interpreted cautiously, especially for endodontically treated teeth. The limitations of this meta-
analysis were small sample sizes in some studies, no applying reference standard test for all patients in some studies, and unavailability of data for subgroup analysis for horizontal and oblique tooth fractures. Moreover, CBCT devices and exposure protocols differed among included studies. According to the authors, since image quality may vary among different CBCT devices and exposure protocols, the results in this meta-analysis should be interpreted with caution and may not be applied to all CBCT devices.

Petersson et al. (2012) completed a systematic review that evaluated the diagnostic accuracy of radiographic methods employed to indicate presence/absence and changes over time of periapical bone lesions. Twenty-six studies fulfilled criteria set for inclusion. None was of high quality; 11 were of moderate quality. According to the authors, there is insufficient evidence that the digital intraoral radiographic technique is diagnostically as accurate as the conventional film technique. The same applies to CBCT. The authors stated that no conclusions can be drawn regarding the accuracy of radiological examination in identifying various forms of periapical bone tissue changes or about the pulpal condition.

Al-Salehi and Horner (2016) evaluated the impact of limited volume CBCT upon diagnosis as part of endodontic management of posterior teeth. Eligible patients were all adults aged 18 years or over who were referred to a specialist endodontic unit. Inclusion criteria were cases that were either re-treatment or de novo root canal treatment where the anatomy was judged to be complex. Exclusion criteria included vulnerable groups and de novo endodontic treatment with uncomplicated root canal anatomy. For each patient, a full history and clinical examination was performed, a high quality color photographic intraoral image, two paralleling technique periapical radiographs and limited volume CBCT examination were carried out. CBT is being increasingly used in field of endodontics. The benefits gained from the use of CBCT must be carefully balanced against the increased radiation dosage. It was concluded that the routine use of CBCT could not be justified.

Implant Dentistry
In a systematic review, Bornstein et al. (2014) reviewed, analyzed, and summarized the available evidence on the use of cross-sectional imaging, specifically maxillofacial cone beam computed tomography (CBCT) in pre- and postoperative dental implant therapy. According to the authors, on the basis of the data found in the literature, the following can be concluded:

- Most published national and international guidelines on implant dentistry do not offer evidence based action statements developed from a rigorous systematic review approach.
- Most publications on guidelines for CBCT use in implant dentistry provide recommendations that are consensus-based or derived from a limited methodological approach with only partial retrieval and/or analysis of the literature or contain even generalized or non-case-specific statements.
- Indications or contraindications reported for CBCT use in implant dentistry are based on nonrandomized clinical trials, either cohort or case-controlled studies.
- The reported indications for CBCT use in implant dentistry vary from preoperative analysis regarding specific anatomic considerations, site development using grafts, and computer-assisted treatment planning to postoperative evaluation focusing on complications due to damage of neurovascular structures.
- It will be difficult to prove a clear and statistically significant benefit of cross-sectional imaging (with special emphasis on CBCT) over conventional two dimensional imaging such as panoramic radiography with respect to damage of the IAN or other vital neurovascular structures in the arches resulting in dysesthesia or pain in comparative prospective studies due to the high number of cases needed for such an evaluation (power).

Shelley et al. (2014) completed a systematic review to determine if the pre-operative availability of cross-sectional imaging, such as cone beam CT, has a diagnostic impact, therapeutic impact or impact on patients' outcome when placing two dental implants in the anterior mandible to support an overdenture. Studies were considered eligible for inclusion if they compared the impact of conventional and cross-sectional imaging when placing dental implants in sites including the anterior mandible. An adapted quality assessment tool was used for the assessment of the risk of bias in included studies. Pooled quantitative analysis was not possible and, therefore, synthesis was qualitative. Of 2374 potentially eligible papers, 5 studies were included. The authors stated that little could be determined from a synthesis of these studies because of their small number, clinical diversity and high risks of bias. The authors concluded that there is no evidence to support any specific imaging modality when planning dental implant placement in any region of the mouth. Therefore, those who argue that cross-sectional imaging should be used for the assessment of all dental implant sites are unsupported by evidence.

Oral Surgery
In a systematic review, Guerrero et al. (2011) evaluated the evidence for the diagnostic efficacy of cone beam computed tomography (CBCT) for impacted teeth and associated features. The literature search yielded 96 titles, of which 7 were included in the review. There was only limited evidence for diagnostic efficacy expressed as sensitivity, specificity and predictive values. Only two studies compared CBCT and panoramic radiographs with a valid reference method and presented the results in terms of percentage of correct diagnoses. The authors stated that the review revealed a need for studies that meet methodological standards for diagnostic efficacy of CBCT in the diagnosis of
impacted teeth. According to the authors, there is a need for randomized controlled trials where different findings of CBCT examination are analyzed in relation to the treatment outcomes. These studies should measure performance of imaging alternatives (CBCT and conventional radiography) for the purpose of making diagnoses and in their contribution to improved management of patients. Furthermore, additional multicentre studies are required to determine when CBCT imaging is needed.

In a randomized controlled multicenter trial Guerrero et al. (2014) compared the postoperative complications following surgical removal of impacted third molars using panoramic radiography (PAN) images- and cone-beam computed tomography (CBCT)-based surgeries for "moderate-risk" cases of impacted third mandibular molars. The secondary objective of the study was to compare the reliability of CBCT with that of PAN in preoperative radiographic determination of the position of the third molar, number of roots, and apical divergence. The sample consisted of impacted third molars from 256 patients with a close relation to the inferior alveolar nerve (IAN). Patients were divided into two groups: the CBCT group (n = 126) and the PAN group (n = 130). The incidences of IAN sensory disturbance and other postoperative complications were recorded for each group at 7 days after surgery. Statistical analysis was used to compare the diagnoses of five trained dentomaxillofacial radiologists and to relate radiologic diagnoses to perioperative findings. Logistic regression was used to determine whether the imaging modality influenced occurrence of postoperative complications. Two extractions (1.5%) in the CBCT group and five (3.8%) in the PAN group resulted in IAN sensory disturbance. Logistic regression models did not show that CBCT modality decreased postoperative complications following surgical removal of impacted third molars. Yet, CBCT revealed the number of roots and apical divergence of the roots more reliably than panoramic radiographs however, the authors concluded that CBCT was not better than panoramic radiography in predicting postoperative complications for moderate-risk cases of impacted third mandibular molars.

Guerrero et al. (2012) conducted a randomized controlled trial to measure sensory disturbances of the inferior alveolar nerve (IAN) after removal of impacted mandibular third molars using cone beam computed tomography (CBCT) and dental panoramic radiography (PAN) for preoperative assessment and to measure the efficacy of the observers' prediction of IAN exposure at surgery based on CBCT compared with PAN. The sample consisted of 86 impacted third molars (from 79 consecutive patients) in close relation to the IAN as determined by PAN and judged as showing a "moderate" risk of IAN damage. Postoperative sensory disturbances occurred in 1 patient in the CBCT group and 1 patient in the PAN group. The light-touch sensation test showed no significant differences at the lip and chin levels for CBCT- versus PAN-based surgery. Significant differences in making a correct diagnosis of neurovascular bundle exposure at the extraction of impacted teeth were found between the 2 modalities. The authors concluded that within the limits of the present pilot study, CBCT was not superior to PAN in predicting postoperative sensory disturbances but was superior in predicting IAN exposure during third molar removal in cases judged as having "moderate" risk.

In a prospective study, Ghaeminia et al. (2011) evaluated the role of cone beam computed tomography (CBCT) in the treatment of patients with impacted mandibular third molars at increased risk of inferior alveolar nerve (IAN) injury. Subjects with an increased risk of IAN injury, as diagnosed on panoramic radiographs, were enrolled in this study and underwent additional CBCT imaging. Two oral maxillofacial surgeons independently planned the surgical technique and estimated the risk of IAN injury on panoramic radiographs and on CBCT images. A test of symmetry and the McNemar test were executed to calculate the differences between the two imaging modalities. The study sample comprised 40 patients presenting with 53 mandibular third molars. Risk assessment for IAN injury based on panoramic radiography compared with CBCT imaging differed significantly. After reviewing the CBCT images, significantly more subjects were reclassified to a lower risk for IAN injury compared with the panoramic radiograph assessments. This change in risk assessment also resulted in a significantly different surgical approach. The results of this study show that CBCT contributes to optimal risk assessment and, as a consequence, to more adequate surgical planning, compared with panoramic radiography. This study is limited by a small study population.

Matzen et al. (2013a) assessed the influence of cone beam CT (CBCT) on treatment planning before surgical intervention of mandibular third molars and identified radiographic factors with an impact on deciding on coronectomy. A total of 186 mandibular third molars with an indication for surgical intervention underwent a radiographic examination with two methods: (1) panoramic imaging in combination with stereo-scanography and (2) CBCT. After the radiographic examination a treatment plan (TP) was established: either surgical removal (Sr) or coronectomy (Co). The first TP was based on the panoramic image and stereo-scanogram, while the second TP was established after CBCT was available. Logistic regression analyses were used to identify factors predisposing for Co after CBCT. Treatment was performed according to the second TP. Agreement between the first and second TP was seen in 164 cases (88%), while the TP changed for 22 teeth (12%) after CBCT. Direct contact between the third molar and the mandibular canal had the highest impact on deciding on Co. Direct contact was not a sufficient factor, however; thus, lumen narrowing of the canal and canal positioned in a bending or a groove in the root complex were additional canal-related factors for deciding on Co. The authors concluded that CBCT influenced the treatment plan for 12%. Direct contact in combination with narrowing of the canal lumen and canal positioned in a bending or a groove in the root

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complex observed in CBCT images were significant factors for deciding on coronectomy. The study did not confirm the utility of such findings in improving care and outcome of patients.

Matzen et al. (2013b) compared the diagnostic accuracy of panoramic imaging, stereo-scanography and cone beam computed tomography (CBCT) for assessment of mandibular third molars. One hundred and twelve patients (147 third molars) underwent radiographic examination by panoramic imaging, stereo-scanography and CBCT. There were no significant differences between the modalities regarding tooth angulation, root morphology and number of roots. However, CBCT was more accurate than stereo-scanography for determining root bending in the bucco-lingual plane. Moreover, sensitivity for direct contact to the mandibular canal was higher for CBCT than for panoramic images and specificity for no direct contact to the mandibular canal was higher for panoramic images and CBCT than for scanograms. The authors concluded that panoramic imaging, stereo-scanography and CBCT seem equally valuable for examination of tooth angulation and number and morphology of roots of mandibular third molars. However, CBCT was more accurate for assessment of root bending in the bucco-lingual plane and more accurate than panoramic images to identify direct contact to the mandibular canal. There is no evidence from this study that this information will affect patient management.

Orthodontics
Van Vlijmen et al. (2012) conducted a systematic review of cone-beam computed tomography (CBCT) applications in orthodontics and evaluated the level of evidence to determine whether the use of CBCT is justified in orthodontics. The authors identified 550 articles, and 50 met the inclusion criteria. The authors found no high-quality evidence regarding the benefits of CBCT use in orthodontics. Limited evidence shows that CBCT offers better diagnostic potential, leads to better treatment planning or results in better treatment outcome than do conventional imaging modalities. Only the results of studies on airway diagnostics provided sound scientific data suggesting that CBCT use has added value. The additional radiation exposure should be weighed against possible benefits of CBCT, which have not been supported in the literature. The authors suggested that future studies should evaluate the effects of CBCT on treatment procedures, progression and outcome quantitatively.

Rossini et al. (2012) analyzed the literature focused on cone-beam computed tomography (CBCT) diagnostic accuracy and efficacy in detecting impacted maxillary canines, and evaluated the possible advantages in using CBCT technique compared with traditional radiographs. The literature search yielded 94 titles, of which 5 were included in the review. Three studies used CBCT technique to 3D localize maxillary impacted canines and assess root resorption of adjacent teeth. The other two publications compared traditional radiographs with CBCT images in the diagnosis of maxillary impacted canines. Only three studies presented the results using statistical analysis. The authors concluded that CBCT has a potential diagnostic effect and may influence the outcome of treatment when compared with traditional panoramic radiography for the assessment of impacted maxillary canines. According to the authors, there is a need of future studies performed according with high level methodological standards, investigating diagnostic accuracy and effectiveness of CBCT in the diagnosis of maxillary impacted teeth. The authors stated that the methodological differences among selected studies (i.e. study sample, materials and methods) revealed the lack of studies performed using methodological standards for diagnostic accuracy and effectiveness of CBCT in the diagnosis of maxillary impacted teeth.

Botticelli et al. (2011) evaluated whether there is any difference in the diagnostic information provided by conventional two-dimensional (2D) images or by three-dimensional (3D) cone beam computed tomography (CBCT) in subjects with unerupted maxillary canines. Twenty-seven patients (17 females and 10 males, mean age 11.8 years) undergoing orthodontic treatment with 39 impacted or retained maxillary canines were included. For each canine, two different digital image sets were obtained: (1) A 2D image set including a panoramic radiograph, a lateral cephalogram, and the available periapical radiographs with different projections and (2) A 3D image set obtained with CBCT. Both sets of images were submitted, in a single-blind randomized order, to eight dentists. A questionnaire was used to assess the position of the canine, the presence of root resorption, the difficulty of the case, treatment choice options, and the quality of the images. Data analysis was performed using the McNemar-Bowker test for paired data, Kappa statistics, and paired t-tests. The findings demonstrated a difference in the localization of the impacted canines between the two techniques, which can be explained by factors affecting the conventional 2D radiographs such as distortion, magnification, and superimposition of anatomical structures situated in different planes of space. According to the authors, the increased precision in the localization of the canines and the improved estimation of the space conditions in the arch obtained with CBCT resulted in a difference in diagnosis and treatment planning towards a more clinically orientated approach. The study did not confirm the utility of such findings in improving care and outcome of patients.

In a prospective study, Alqerban et al. (2013) compared the impact of using two-dimensional (2D) panoramic radiographs and three-dimensional (3D) cone beam CT for the surgical treatment planning of impacted maxillary canines. The study included of 32 subjects (19 females, 13 males) with a mean age of 25 years, referred for surgical intervention of 39 maxillary impacted canines. Initial 2D panoramic radiography was available, and 3D cone beam CT
imaging was obtained upon clinical indication. Both 2D and 3D pre-operative radiographic diagnostic sets were subsequently analyzed by six observers. Perioperative evaluations were conducted by the treating surgeon. McNemar tests, hierarchical logistic regression and linear mixed models were used to explore the differences in evaluations between imaging modalities. Significantly higher confidence levels were observed for 3D image-based treatment plans than for 2D image-based plans. The evaluations of canine crown position, contact relationship and lateral incisor root resorption were significantly different between the 2D and 3D images. By contrast, pre- and perioperative evaluations were not significantly different between the two image modalities. The authors concluded that surgical treatment planning of impacted maxillary canines was not significantly different between panoramic and cone beam CT images.

**Periodontics**

Leonardi et al. (2016) conducted a systematic review and meta-analysis assessed the diagnostic accuracy of conventional radiography and cone-beam computed tomographic (CBCT) imaging on the discrimination of apical periodontitis (AP) from no lesion. A meta-analysis was conducted on 6 of the 9 articles. All the articles studied artificial AP with induced bone defects. Periapical radiographs (digital and conventional) reported good diagnostic accuracy on the discrimination of artificial AP from no lesions, whereas CBCT imaging showed excellent accuracy values.

Walter et al. (2009) investigated the use of cone beam computed tomography (CBCT) in assessing furcation involvement (FI) and concomitant treatment decisions in maxillary molars. Twelve patients with generalized chronic periodontitis were consecutively recruited and CBCT was performed in maxillary molars (n=22) with clinical FI and increased probing pocket depths. CBCT images were analyzed and FI, root length supported by bone and an anotomical features were evaluated. FI and treatment recommendations based on clinical examinations and periapical radiographs were compared with data derived from CBCT images. The estimated degree of FI based on clinical findings was confirmed in 27% of the sites, while 29% were overestimated and 44% revealed an underestimation according to CBCT analyses. Among degree I FI, 25% were underestimated, among degree II and II-III, the underestimation was as high as 75%, while all sites with degree III FI were confirmed in the CBCT. Discrepancies between clinically and CBCT-based therapeutic treatment approaches were found in 59-82% of the teeth, depending on whether the less invasive or the most invasive treatment recommendation was selected for comparison. The authors concluded that CBCT images of maxillary molars may provide detailed information of FI and a reliable basis for treatment decision. There is no evidence from this study that this information will affect patient management.

Grimard et al. (2009) compared the measurements from digital Intraoral radiograph (IR) and cone-beam volumetric tomography (CBVT) images to direct surgical measurements for the evaluation of regenerative treatment outcomes. Digital IR and CBVT images were taken prior to initial bone grafting and at the 6-month reentry surgery for 35 intrabony defects. After defect debridement, direct bony defect measurements were made with a periodontal probe. These same measurements were made on the IR and CBVT images and then compared to the direct surgical values. CBVT correlated strongly with surgical measurements, whereas IRs correlated less favorably. IR measurements were significantly less accurate compared to CBVT for all parameters investigated and underestimated surgical measurements from 0.6 +/- 2.3 mm to 1.5 +/- 2.3 mm. No significant difference for the distance from the cemento-enamel junction (CEJ) to the alveolar crest, defect fill, or defect resolution was seen between CBVT and surgical measurements; however, there was a significant difference for the distance from the CEJ to the base of the defect, with CBVT measurements underestimating the surgical measurements by 0.5 +/- 1.1 mm for reentry and 0.9 +/- 0.8 mm for the initial measurement. The authors concluded that compared to direct surgical measurement, CBVT was significantly more precise and accurate than IRs. The study did not confirm the utility of such findings in improving care and outcome of patients.

**Professional Societies**

American Association of Endodontists (AAE) and American Academy of Oral and Maxillofacial Radiography (AAOMR)

A position statement for the use of cone-beam-computed tomography in endodontics was prepared by the AAE Special Committee on Cone-Beam-Computed Tomography in conjunction with members of the AAOMR (AAE and AAOMR, 2015). This joint position statement 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 release.

In general, CBCT is categorized into large, medium and limited-volume units based on the size of the “field of view” (FOV). The size of the FOV describes the scan volume of CBCT machines. In endodontics, 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. The position statement identifies the recommendations for the limited FOV CBCT scans based on diagnosis, treatment and special conditions.
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.

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.

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

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.

Special Conditions
Implant Placement
- Recommendation 10: Limited FOV CBCT should be considered as the imaging modality of choice for surgical placement of implants.

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.

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.

See the following for additional information:

American Academy of Oral and Maxillofacial Radiology (AAOMR)
A position statement developed by consensus agreement by a panel convened by the AAOMR summarized the potential benefits and risks of maxillofacial cone beam computed tomography (CBCT) use in orthodontic diagnosis, treatment and outcomes. The panel reviewed literature on the clinical efficacy of and radiation dose concepts associated with CBCT in all aspects of orthodontic practice and concluded that the use of CBCT in orthodontic treatment should be justified on an individual basis, based on clinical presentation. Despite the number of publications
on the use of CBCT for specific orthodontic applications, most are observational studies of diagnostic performance and efficacy with wide ranging methodological soundness. According to the panel, few authors have presented higher levels of evidence and measured the impact of CBCT on orthodontic diagnosis and treatment planning decisions (AAOMR, 2013).

In an executive opinion statement on performing and interpreting diagnostic cone beam computed tomography, the AAOMR states that the use of CBCT technology is encouraged within the practice of dentistry where this results in health care benefits for the patient (Carter, 2008).

A Position Paper Subcommittee of the American Academy of Oral and Maxillofacial Radiology (AAOMR) reviewed the literature on selection criteria for radiology in dental implantology (Tyndall, 2012). All current planar modalities, including intraoral, panoramic, and cephalometric, as well as cone beam computed tomography (CBCT) are discussed, along with radiation dosimetry and anatomy considerations. The AAOMR made the following recommendations:
- Do not use cross-sectional imaging, including CBCT, as an initial diagnostic imaging examination.
- CBCT should be considered as the imaging modality of choice for preoperative cross-sectional imaging of potential implant sites.
- CBCT should be considered when clinical conditions indicate a need for augmentation procedures or site development before placement of dental implants: (1) sinus augmentation, (2) block or particulate bone grafting, (3) ramus or symphysis grafting, (4) assessment of impacted teeth in the field of interest, and (5) evaluation of prior traumatic injury.
- CBCT imaging should be considered if bone reconstruction and augmentation procedures (e.g., ridge preservation or bone grafting) have been performed to treat bone volume deficiencies before implant placement.
- Use cross-sectional imaging (particularly CBCT) immediately postoperatively only if the patient presents with implant mobility or altered sensation, especially if the fixture is in the posterior mandible.
- Do not use CBCT imaging for periodic review of clinically asymptomatic implants.
- Cross-sectional imaging, optimally CBCT, should be considered if implant retrieval is anticipated.

American Dental Association Council on Scientific Affairs (ADACSA)
In an advisory statement for the use of cone-beam computed tomography (CBCT) in dentistry, the ADACSA recommends that no radiographic examinations, including CBCT, should be performed for screening purposes and that CBCT should only be considered as an adjunct to standard oral imaging modalities. The ADACSA states that the clinician should prescribe traditional dental radiographs and CBCT scans only when he or she expects that the diagnostic yield will benefit patient care, enhance patient safety, and significantly improve clinical outcomes or all of these. The ADACSA also states that CBCT should be considered as an adjunct to standard oral imaging modalities and may supplement or replace conventional (two-dimensional or panoramic) dental radiography for the diagnosis, monitoring and treatment of oral disease or the management of oral conditions when, in the clinician’s decision-making process, he or she determines that oral anatomical structures of interest may not be captured adequately by means of conventional radiography (ADACSA, 2012).

European Academy of Dental and Maxillofacial Radiology (EADMF)
The EADMF has developed basic principles on the use of dental cone beam CT by consensus its membership (Horner, 2009). Specifically, the EADMF recommends that CBCT examinations must be justified for each patient to demonstrate that the benefits outweigh the risks and CBCT examinations should potentially add new information to aid the patient’s management.

European Society of Endodontology (ESE)
The ESE has released a position statement that represents a consensus of an expert committee convened by the ESE on the use of cone beam computed tomography (CBCT) (Patel, 2014). According to the position statement, a request for a CBCT scan should only be considered if the additional information from reconstructed three-dimensional images will potentially aid formulating a diagnosis and/or enhance the management of a tooth with an endodontic problem(s). The ESE recommends that cone beam computed tomography with a limited field of view (FOV) be considered in the following situations:
- Diagnosis of radiographic signs of periapical pathosis when there are contradictory (nonspecific) signs and/or symptoms;
- Confirmation of nonodontogenic causes of pathosis;
- Assessment and/or management of complex dento-alveolar trauma, such as severe luxation injuries, suspected fracture of the overlying alveolar complex and horizontal root fractures, which may not be readily evaluated with conventional radiographic views;
- Appreciation of extremely complex root canal systems prior to endodontic management (for example, class III & IV dens invaginatus);
- Assessment of extremely complex root canal anatomy in teeth treatment planned for non-surgical endodontic re-treatment;
Assessment of endodontic treatment complications (for examples, [post] perforations) for treatment planning purposes when existing conventional radiographic views have yielded insufficient information;
Assessment and/or management of root resorption, which clinically appears to be potentially amenable to treatment;
Pre-surgical assessment prior to complex periradicular surgery (for example posterior teeth).

U.S. FOOD AND DRUG ADMINISTRATION (FDA)

Devices used for computed tomography are classified under the following product codes:
- JAK (system, X-ray tomography, computed)
- MUH (system, X-ray, extraoral source, digital)
- OAS (X-ray, tomography, computed, dental)

There are many 510(k) approvals for these codes, not all of which are for cone-beam computed tomography devices or for devices used for craniofacial imaging. For information on a specific device or manufacturer, search the Center for Devices and Radiological Health (CDRH) 510(k) database by product and/or manufacturer name then check for the appropriate indication in the Summary section of the results:

In a document for radiation-emitting products: dental cone-beam computed tomography, the FDA states that dental CBCT should be performed only when necessary to provide clinical information that cannot be provided using other imaging modalities. See the following for more information: http://www.fda.gov/RadiationEmittingProducts/RadiationEmittingProductsandProcedures/MedicalImaging/MedicalX-Rays/ucm315011.htm. (Accessed September 14, 2016)

Additional Products
CBCT scanners specifically designed for orofacial imaging are available from several manufacturers, including but not limited to Hitachi (CB MercuRay™), Imaging Sciences International (i-Cat®), AFP Imaging (NewTom Systems), Soredex (Scanora® 3D), and Xoran Technologies (MiniCAT™).

REFERENCES


### POLICY HISTORY/REVISION INFORMATION

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<td>Updated supporting information to reflect the most current clinical evidence, FDA information and references; no change to coverage rationale or list of applicable codes</td>
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