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EDITORIAL

Use of dentomaxillofacial cone beam computed tomography in dentistry

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Abstract

Cone-beam computed tomography (CBCT) was developed and introduced specifically for dento-maxillofacial imaging. CBCT possesses a number of advantages over medical CT in clinical practice, such as lower effective radiation doses, lower costs, fewer space requirements, easier image acquisition, and interactive display modes such as mutiplanar reconstruction that are applicable to maxillofacial imaging. However, the disadvantages of CBCT include higher doses than two-dimensional imaging; the inability to accurately represent the internal structure of soft tissues and soft-tissue lesions; a limited correlation with Hounsfield Units for standardized quantification of bone density; and the presence of various types of image artifacts, mainly those produced by metal restorations. CBCT is now commonly used for a variety of purposes in oral implantology, dento-maxillofacial surgery, image-guided surgical procedures, endodontics, periodontics and orthodontics. CBCT applications provide obvious benefits in the assessment of dentomaxillofacial region, however; it should be used only in correct indications considering the necessity and the potential hazards of the examination.

Key words: Radiography; Dentistry; Dentomaxillofacial; Radiology; Cone-beam computed tomography

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Core tip: Cone-beam computed tomography (CBCT) is now commonly used for a variety of purposes in oral implantology, dento-maxillofacial surgery, image-guided surgical procedures, endodontics, periodontics and orthodontics. CBCT applications provide obvious benefits in the assessment of dentomaxillofacial region, however; it should be used only in correct indications considering the necessity and the potential hazards of the examination.

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CONE BEAM COMPUTED TOMOGRAPHY

Cone-beam computed tomography (CBCT) was developed and introduced specifically for dento-maxillofacial imaging[1]. A practical cone-beam algorithm for tomographic reconstruction of 2-D projection data was first illustrated by Feldkamp in 1984, who, used a back-projection formula to directly reconstruct a 3-D density function from a set of two-dimensional projections. CBCT units dedicated to dento-maxillofacial radiology could not be marketed for another 15 years because economic X-ray tubes, high-quality detector systems and sufficiently powerful personal computers were unavailable. Eventually, in 1999, the first dento-maxillofacial CBCT unit, the NewTom DVT 9000, designed by Attilio Tacconi and Piero Mozzo and produced by QR, Inc. of Verona, Italy, was introduced in Europe[2,3]. Today, new technological specifications and settings include multiple field of views (FOVs) and voxels that can better address a variety of specific tasks. There are also several hybrid machines offering CBCT imaging along with panoramic and cephalometric radiography. CBCT possesses a number of advantages over medical CT in clinical practice, such as lower effective radiation doses, lower costs, fewer space requirements, easier image acquisition, and interactive display modes such as mutiplanar reconstruction that are applicable to maxillofacial imaging. However, the disadvantages of CBCT include higher doses than two-dimensional imaging; the inability to accurately represent the internal structure of soft tissues and soft-tissue lesions; a limited correlation with Hounsfield Units for standardized quantification of bone density; and the presence of various types of image artifacts, mainly those produced by metal restorations[4-6].

CBCT is now commonly used for a variety of purposes in oral implantology, dento-maxillofacial surgery, image-guided surgical procedures, endodontics, periodontics and orthodontics. Whereas early CBCT devices were dedicated to implantology and dental imaging, today, applications extend to the face and skull base as a whole. Depending on the FOV used, CBCT images may show part or all of the nasal cavity, paranasal sinuses, airway, cervical vertebrae and temporal bone. In fact, specific ear, nose and throat imaging programs have been increasingly included in CBCT systems, suggesting that CBCT may at some point entirely replace medical CT imaging in certain otolaryngology-related applications[3]. CBCT has also been found to provide reliable and accurate 3D analysis of the upper airway that can be of help in assessing the presence and severity of obstructive sleep apnea[7]. Imaging of the temporal bone represents another promising area for CBCT, whose high-resolution and nearly artifact-free multi-planar reconstruction images make it possible to precisely assess the intra-cochlear position of the electrode, including visualization of each individual contact[8].

Concerns over liability issues related to CBCT remain unresolved. CBCT machines are increasingly being marketed specifically to orthodontists and implantologists or dentists who place implants in private practices. Unlike other advanced medical imaging systems, CBCT scanners are generally owned and operated by non-radiologists who lack the training necessary to interpret CBCT images. However, clinicians who order CBCT scans are responsible for interpreting the entire image volume, given the possibility that incidental findings - the likelihood of which increase when a larger head volume is included in the scan - may have significant health consequences for the patient[6]. There is no informed consent process or signature waiver that would allow the clinician to interpret only a specific area of an image volume. As a result, the clinician may be considered liable for a missed diagnosis, even one that falls outside the area of his/her expertise. In case of any questions regarding image data interpretation, referral to a specialist in oral and maxillofacial or medical radiology is recommended[6,9].

CBCT applications provide obvious benefits in the assessment of dentomaxillofacial region, however; it should be used only in correct indications considering the necessity and the potential hazards of the examination. Comparative radiation dosages should be weighed against diagnostic benefits in selecting the appropriate imaging modality for specific purposes. Future improvements in CBCT imaging can be expected to result in novel systems with better diagnostic abilities and lower effective doses[10].

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