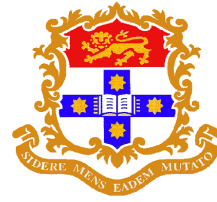


Australian Society
of Orthodontists



University of Sydney



Cone Beam Computed Tomography (CBCT) in Orthodontics

*Creating **B**righter Futures*

3-dimensional (3D) radiography or Cone Beam Computed Tomography (CBCT) has had a significant impact on orthodontic diagnosis, treatment planning, and evaluation of treatment outcomes. Software manipulation has allowed enhanced hard tissue and, to a lesser extent, soft tissue visualization in the three planes of space.^[1]

Use in Orthodontics and Patient Selection

Responsible use of CBCT involves identification of cases that would benefit from 3D rather than 2D radiographic assessment and the skills to manipulate and interpret the 3D DICOM files.

Whether CBCT should be used in a few selected clinical situations^[2], or routinely for all new orthodontic patients is still a matter of debate. Some suggest its use when additional information is required, for example an impacted tooth, a supernumerary tooth or missing teeth, while others use CBCT to provide additional information for diagnostic purposes and identify incidental findings.^[3]

Orthodontic clinical indications for acquiring a CBCT includes the following conditions and procedures: cleft lip and palate, post trauma imaging, root resorption or inadequate and aberrant root formation, supernumerary teeth, pathology, temporomandibular joint evaluation, airway evaluation, orthognathic surgery treatment planning, and placement of temporary anchorage devices (TADs). In addition three dimensional assessment of unerupted and/or impacted teeth such as canines accurately determines position and orientation in relation to relevant anatomical structures and adjacent teeth^[4]. This is particularly useful in planning surgical exposure and orthodontic treatment mechanics for more reliable management of the impacted tooth^[5].

Maxillary incisor root resorption has been reported to be present in 27.2% of lateral incisors and 23.4% of central incisors in close contact with canines^[4].

2D radiography was previously used as a diagnostic tool for root resorption, however a quantitative appraisal with such scans is inaccurate^[6]. 3D imaging has more recently shown greater accuracy in quantitatively analyzing the locations, dimensions, and volume of root resorption craters in extracted orthodontically moved teeth^[7].

3D imaging can provide comprehensive information for multidisciplinary management of facial trauma where bleeding, swelling and discomfort would limit the use of 2D imaging and sometimes interfere with provision of appropriate treatment^[8]. Furthermore, CBCT imaging can

be used for evaluation of anatomical structures to identify asymmetry within structures and its relationship with a given malocclusion^[9].

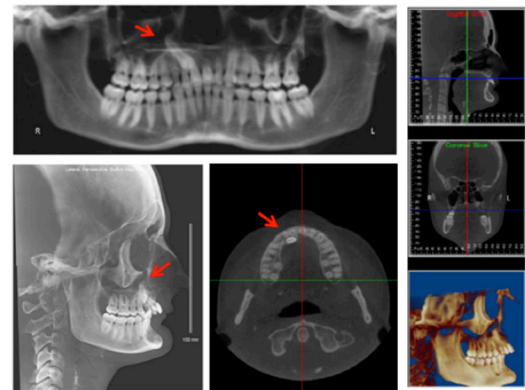


Figure 1 Palatally Impacted 13

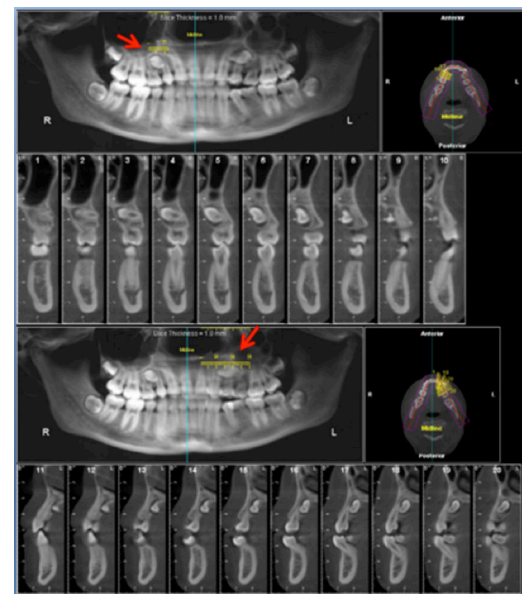


Fig 2 Horizontally impacted 15 and 25

Radiation Dosage

The ALARA Principle (As Low As Reasonably Achievable) mandates that patients should be exposed only to the minimum amount of radiation necessary to provide the diagnostic and treatment information required. Every available means of reducing dosage consistent with good diagnostic quality should be employed.

Colgate CARE COLUMN

The Oral Health Advisory Panel (OHAP), a new collaboration of esteemed healthcare professionals, officially launches this October.

The establishment of the panel aims to lead the dialogue on good oral health habits and the importance of establishing these habits at an early age. By taking a holistic view to improving oral health the long-term outcomes could lead to a deeper understanding of the benefits for all Australians.

The Panel is the first of its kind in Australia to bring together such a group of independent professionals in order to leverage their expert and holistic perspective for the benefit of Australians' oral health. Working with Colgate, which is also represented on the Panel, OHAP's inaugural meeting took place this month in Sydney.



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The Australian Radiation Protection and Nuclear Safety Agency (ARPNSA) guidance stipulate that a person should receive no more than 1 millisievert (mSv) of radiation in a given year. This corresponds to the yearly average accumulated background to an individual.^[10]

Examples of effective radiation doses of various craniofacial imaging acquisition systems are listed in Table 1, indicating lower radiation exposure for CBCT compared to computed tomography (CT) but higher than OPG or lateral cephalometric exposure.

Nevertheless, CBCT dose varies considerably between machines in addition to chosen features and settings.^[11-13] The key factor in that is the field of view (FOV) being used. Other features can also determine radiation dosage delivered using CBCT, including scan arc, scan time, resolution, kilovolts peak (kVp), and milliamperage (mA) used in the scan.^[13]

CBCT is justified when multiple separate radiographs are required for specific or comprehensive orthodontic assessments. The radiation level delivered by the sum of all conventional films required for a patient can sometimes exceed that provided by a CBCT scan.^[14]

Acquisition	Effective Dose	Equivalent natural background radiation
CT full skull	0.93 mSv	97 days
CT mandible, maxilla, eyes	0.41 mSv	50 days
CT mandible, maxilla	0.31 mSv	38 days
CT dental mandible	0.27 mSv	33 days
CT dental maxilla	0.21 mSv	26 days
CBCT full view high resolution maxilla and mandible	0.15 mSv	18 days
CBCT restricted field low resolution maxilla or mandible only	0.05 mSv	6 days
Cephalogram	0.03 mSv	4 days
OPG	0.03 mSv	4 days

Table 1 - Effective radiation doses of various craniofacial imaging acquisition systems. These figures are indicative and may vary.

Some recently improved features claimed by the CBCT machine manufacturers include dose reduction, and high definition (HD) cephalometric update for improved patient protection.

Ultimately, it is the practitioner's responsibility to use a reliable brand that will deliver the least possible radiation and highest quality 3D information.

Resolution Variation

Resolution of CBCT scans varies according to voxel size and number. A voxel is a 3D unit (cube) representing a unit of 3D data, just as pixels determine 2D resolution. Improved 3D technology and resolution should lead to these scans replacing clinical procedures such as impressions. Dental scans will very likely be used for digitally generated models, indirect bonding systems, and for the fabrication of appliances such as customized bracket bases, slots and archwires.^[1, 15-17]

FOV and Multifunctionality

Table 2 shows a broad differentiation of fields of view, classified as small, medium or large depending on whether the area of interest is limited to the dentition, joints or

lateral skull view respectively. Some CBCT machines have both 2D and 3D exposure.^[12-14]

Scanner FOV size	Small	Medium	Large
Anatomical View	User defined region, usually symmetrical in shape.	Middle of the orbits down to Menton vertically. Inter condyle horizontal distance	Nasion and roof of the orbit down to the hyoid bone.
Scanner Use	Implant and TMJ surveys and impacted teeth	Implant and Orthopantomogram Survey	Cephalometric and orthodontic surveys.

Table 2 - Different available FOV^[12,13]

Reading CBCT Files

Digital data from the CBCT scans can be recorded as DICOM files (Digital Imaging and Communication in Medicine) which is a universal file format that can be read using dedicated software (DICOM viewer). The DICOM files can be exported offsite to a radiologist and relevant findings provided as a written report, radiographic or 3D images. Increasingly, these services are available online.^[1]

Risk and Responsibility

There are medico-legal and ethical implications regarding responsibility if an abnormality or pathology is not recognized or detected from a CBCT scan. It is therefore prudent that dental practitioners ensure that their patients' DICOM data is referred to a qualified radiologist who can interpret the relevant information and liaise with an appropriate expert for supplementary evaluation if indicated.^[18]

Training in the recognition of abnormalities of the head and neck is recommended as well as familiarity with specific regulations relevant to practitioners engaged in the use of CBCT technology.

Current and future benefits of using CBCT Scan

Some of the advantages are listed below [1, 3, 4, 9, 19]:

- Better image resolution
- More accurate structure identification
- Image bone and soft tissue in high resolution
- Accurate structure measuring (implant placement, root canal and reconstructive surgery)
- Identification of an incidental finding
- One-click cephalometric image
- One-click panoramic image
- Onscreen models with segmented teeth
- Visual treatment objective capability
- Onscreen articulator
- Ability to superimpose DICOM files
- Auto-cuts (i.e., click on impacted maxillary canine and see diagnostic cuts which can be "fine-tuned")
- Pathology cuts
- Affordability
- Ability to measure the teeth
- Bolton analysis
- Virtual extraction
- Ability to move the teeth
- Idealized setup
- Fabricate appliances
- Less chair time during records appointment
- Better occlusal DICOM data (Centric occlusion splint required for scan)

BRIGHTER FUTURES

is published by the Australian Society of Orthodontists (NSW Branch) Inc. in conjunction with the Orthodontic Discipline at the University of Sydney.

The newsletter is intended to help keep the dental profession updated about contemporary orthodontics, and also to help foster co-operation within the dental team.

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Conclusion

CBCT imaging can allow improvements in diagnosis and treatment planning over that achievable with the conventional radiographic techniques alone. Ultimately, better patient outcomes will result.

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