CBCT for general practitioners

CBCT scans can be highly diagnostic and contribute valuable additional information in general practice.

Background

Dental treatment planning relies substantially on dental imaging. As the complexity of dental treatment has evolved, so have our imaging requirements, and cone-beam computed tomography (CBCT) is now becoming more utilised in general practice.[1] CBCT uses a cone-shaped beam that rotates around the patient and produces a cylindrical 3D image. This means that in comparison to medical CT, much smaller volumes can be acquired, which have a beneficial effect on radiation dose.[2] The aim of this paper is to support the general practitioner to maximise the diagnostic quality of CBCT scans and optimise patient safety.

Applications of CBCT

Despite the advantages CBCT has over conventional 2D imaging, the radiation dose is higher, so CBCT should only be carried out by general practitioners when 2D imaging fails to provide the necessary information for diagnosis/treatment planning. Certain applications of CBCT will be limited to specialist dentistry; for example, evaluation of periodontal bony defects will be primarily done by periodontists. When assessment of the proximity of the inferior dental canal (IDC) to lower third molars or facial trauma is required, these scans will usually be requested by oral or maxillofacial surgeons. **Table 1** illustrates the uses of CBCT in general practice.

Limitations of CBCT

CBCT, like every imaging modality, has several limitations. CBCT scans for implant planning are increasing in use. However, it is generally accepted that bone quantity (bone height and width of alveolar crest) can be assessed, but bone quality, which is traditionally based on Houndsfield units, is only available on medical CT. Bone density encompasses degree of mineralisation, trabecular pattern and morphology, and these are not demonstrated well enough for accurate assessment on CBCT.

One of the major limitations of CBCT images is poor soft tissue contrast resolution. This is due to scatter radiation because of structures outside the field of view (FOV) being imaged and included in the FOV. When the X-ray beam interacts with the patient's tissues, it is scattered in multiple directions and has the effect of degrading image quality. This is particularly challenging where the patient has metallic restorations (**Figure 1**). Scatter causes streak artefacts, which give dark streaks adjacent to metal and/or bone. White/bright streaks are seen adjacent to the dark streaks. These have the effect of mimicking caries and additional root canals, so must be interpreted with caution.

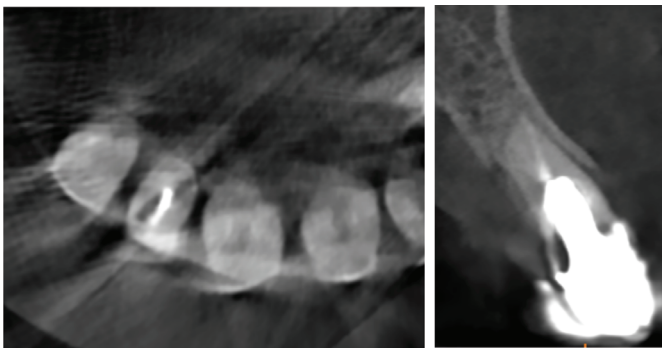

FIGURE 1: Examples of streak artefact due to metallic restorations.

Table 1: Uses of CBCT in general practice.

Procedure	Application	Advantage	Disadvantage
Caries detection	Not recommended		
Periodontal evaluation	Not routinely recommended	May be useful for evaluating bony defects/furcation involvement	Higher radiation dose
Pre-extraction assessment	Used for evaluation of IDC relationship to lower third molars. Complicated root morphology assessment	Can be used to assess root anatomy and proximity to vital anatomical structures	Higher radiation dose
Dental trauma	Dental fracture Alveolar bone fracture assessment	Can be superior to 2D imaging for detection of root fractures	Streak artefact from endodontically treated teeth makes assessment difficult
Implant planning	Used for treatment planning/fabrication of surgical guides	Accurate assessment of bone quantity possible	Limited assessment of bone quality possible
Endodontics	Used for assessment of root resorption, additional canals, complex root anatomy	Small FOV gives lots of additional information	Gutta-percha will produce beam hardening artifacts that can be confused with additional canals

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Clinical tip – metallic artefact reduction

If a patient has a lot of metallic restorations, the patient can be positioned to minimise streak artefact. Metal artefacts will appear in the horizontal plane relative to the patient's position. If the patient's head is tilted, the artefacts can be deflected from the area of interest, giving a much more diagnostic scan (**Table 2**).

Image quality

During a CBCT scan the X-ray tube and detector rotate around the patient's head, and hundreds of 2D images are produced and captured by the detector. These are then reconstructed into a 3D representation of the area that was scanned.

There are four basic parameters that influence image quality: spatial resolution; contrast; artefacts; and, noise.

To help ensure the highest quality diagnostic scan, taking the smallest scan that captures the area of interest has a number of important advantages.

Clinical tip – take the smallest volume scan possible

This achieves:

- reduced noise, as the larger the field, the more scatter that will be incorporated in the scan;
- reduced scan time, which minimises the potential for patient movement;
- reduced radiation dose to the patient; and,
- reduced reporting time for the clinician.

Sample cases

Case 1 – assessing bone volume for dental implant placement

In this case, the clinician queried bone volume in the LR6 area for implant placement (**Figure 2**).

Case 2 – tooth root displacement into the maxillary sinus

This patient was referred after a difficult extraction and the dentist was aware that an oro-antral communication (OAC) was present. The terminal 5mm of the mesiobuccal root could not be accounted for and there was a query whether it was in the sinus. CBCT reveals the presence of a root fragment in the ethmoid infundibulum right maxillary sinus (**Figure 3**).

Case 3 – endodontic assessment

This patient presented complaining of pain in the upper left lateral incisor. The tooth was tender to percussion, slightly mobile, and a periapical radiograph showed a periapical radiolucency. However, the vitality test was positive. CBCT shows a second, separate pulp chamber, which accounts for the positive vitality test (**Figure 4**). The main canal had become non-vital and was successfully endodontically treated.

Conclusion

CBCT scans can be highly diagnostic and contribute valuable additional information in certain cases. This will benefit both patients and clinicians in general practice.

References

1. Patel S, Harvey S. Guidelines for reporting on CBCT scans. *Int Endod J.* 2021;54(4):628-633.
2. Zaman MU. Comparing radiation doses in CBCT and medical CT imaging for dental applications. J Pharm Bioallied Sci. 2024;16(Suppl. 1):S883-S885.

Table 2: Patient positions to minimise streak artefact.

Region of interest	Position
Anterior maxilla	Tilt chin up
Premolar area maxilla and mandible	Occlusal plane horizontal
Posterior maxilla	Tilt chin down
Anterior mandible	Tilt chin down
Posterior mandible	Tilt chin up

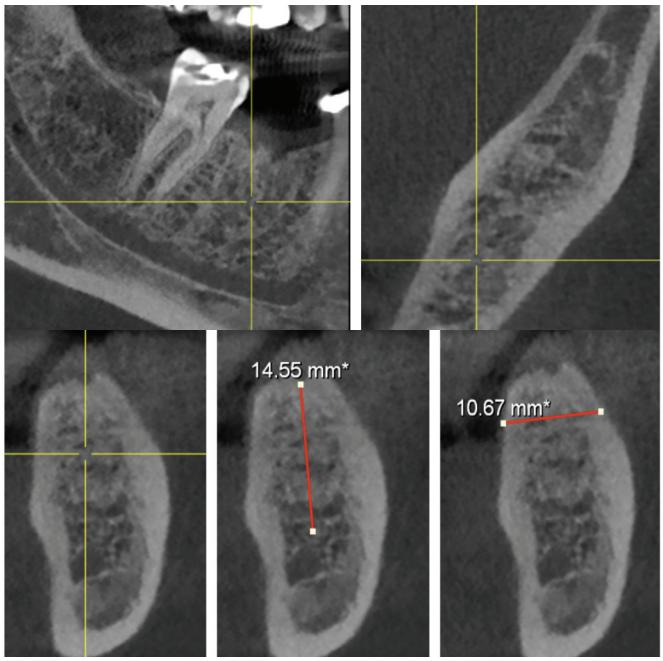

FIGURE 2: Case 1 – illustration of the 3D bone volume measurement procedure. Bony height, width and spatial relationship to the IDC can be visualised and accurately measured. In challenging cases, digital imaging and communications in medicine (DICOM) data from CBCT scans may be combined with stereolithographic (STL) data from intra-oral optical scans to fabricate tooth-supported restrictive surgical guides.

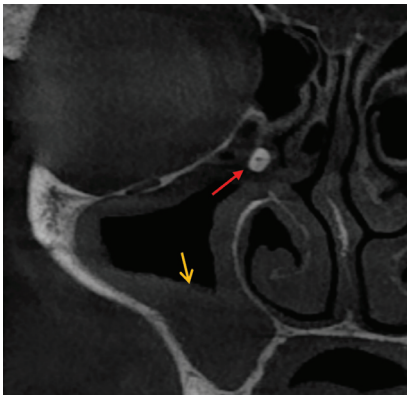

FIGURE 3: Case 2 – root fragment identified (red arrow). Note accompanying mucositis (yellow arrow). In health, the normal mucosal lining of the sinus is less than 1mm in thickness.

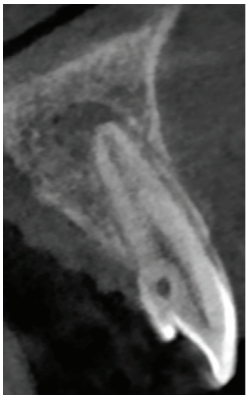

FIGURE 4: Case 3 – CBCT image showing a separate pulp chamber.