Dental panoramic tomography: An approach for the general radiologist

R Boeddinghaus and A Whyte
Perth Radiological Clinic, Perth, Western Australia, Australia

SUMMARY

Dental panoramic tomography is commonly presented to radiologists with no dental training for interpretation. An overview of the technique, basic anatomy and nomenclature and common pathology is presented with examples to show the anatomy and nomenclature, the artefacts and common pathology.

Key words: dental panoramic tomography.

INTRODUCTION

Dental panoramic tomography, also known as orthopantomography (OPG), is a commonly carried out technique. Many radiologists have little knowledge of dental pathology and terminology, but are presented with these examinations daily, often with scant clinical information. An approach to the orthopantomogram is presented to allow the general radiologist to ensure technical quality and provide a reasonable interpretation of the findings.

Dental disease has general medical importance. For example, chronic periodontitis has been implicated as a risk factor for coronary artery disease and atherosclerosis in general,1 and there is still significant morbidity and occasional mortality from dental sepsis.2 The symptoms of dental disease may be confused with those of maxillary sinus disease and vice versa. Mucosal thickening in the maxillary antra is frequently associated with periapical inflammation in the absence of significant primary sinus inflammation.3

TECHNIQUE

The X-ray tube and film (or other image receptor) rotate about the head of the patient, at different velocities, resulting in a flat representation of the curved surfaces of the jaws. As with other conventional tomography, only objects in the image layer (or focal trough) remain in focus, other structures appearing blurred and distorted. Positioning is therefore crucial to ensure that the teeth and jaws are within the image layer.4 All foreign objects, including dental appliances, spectacles and earrings are removed. The patient’s head is positioned in a forehead or chin rest and the correct position relative to the focal trough is achieved by having the incisors resting in a radiolucent notched positioning device, the bite block. The patient should rest the tongue against the palate to prevent a radiolucent band appearing above the maxillary teeth (Fig. 1). The exposure is long and it may be helpful to show a cycle of the machine before starting, to explain to the patient the need to remain still. Unlike the intraoral radiographs commonly carried out by dental practitioners, dental panoramic tomography is carried out with intensifying screens to limit the radiation dose. The spatial resolution is therefore lower and subtle carious and periapical lesions may not be visible.4

The technical expertise required to carry out this examination should not be underestimated. Common positioning errors can be easily recognized.5 If the head is tilted antero-inferiorly (chin down), an exaggerated convex inferior curve of the occlusal plane results (‘smiley’) and the mandibular incisor roots are blurred (Fig. 2). The opposite, chin up, position is recognized by flattening or ‘frowning’ of the occlusal plane and results in blurring of the maxillary incisors (Fig. 3). As a rule of thumb, the occlusal plane should be tilted 20–30° antero-inferiorly, achieved by placing the head so that a line from the tragus to the outer canthus is horizontal. A slumped neck results in a wide
Artefactual lucency projected immediately superior to the roots of the anterior maxillary teeth: this results from failure to place the tongue against the hard palate. There is also a wide radiopaque band from the cervical spine projected over the anterior jaws: this results from a slumped position. There is steep mesio-angular impaction of both mandibular third molars and both maxillary third molars are mildly overerupted.

Fig. 1. Artefactual lucency projected immediately superior to the roots of the anterior maxillary teeth: this results from failure to place the tongue against the hard palate. There is also a wide radiopaque band from the cervical spine projected over the anterior jaws: this results from a slumped position. There is steep mesio-angular impaction of both mandibular third molars and both maxillary third molars are mildly overerupted.

Fig. 4. Rotation artefact. In this patient with mixed dentition, the head is rotated to the left resulting in subtle apparent widening of the left mandibular ramus and of the left molar teeth.

Fig. 5. Mandibular skeletal asymmetry resulting from prior juvenile chronic arthritis of the right temporomandibular joint.

Fig. 6. The head is positioned too far anteriorly and the incisors appear narrow and blurred. This patient has generalized horizontal alveolar bone loss secondary to periodontal disease.

vertical radiopaque band projected over the anterior jaws (Fig. 1). Rotation results in magnification of the side to which the head is rotated (Fig. 4) and should not be mistaken for skeletal asymmetry (Fig. 5). Comparison of the widths of the mandibular molar teeth on either side is useful to detect subtle rotation. If the patient’s head is positioned too far anteriorly, the incisors appear narrow and blurred (Fig. 6) and if too far posteriorly, widened and blurred (Fig. 7).

Dentine, which makes up the bulk of the tooth, is covered by an enamel cap on the crown and by a layer of cementum on the root. The enamel is very dense and is readily distinguishable from dentine whereas cementum has similar density to dentine and is not radiographically visible separate from the dentine. Nonetheless, the position of the cemento-enamel junction can be inferred (Fig. 8). The radiolucent pulp chamber in the crown is continuous with the root canal. A thin radiolucent periodontal

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ligament space separates the root from the dense bone making up the lamina dura (Fig. 8).

The curved structure of the jaws requires a special nomenclature for anatomical relationships: mesial is closer to the anterior midline, distal is further posterolaterally located within the jaw. Buccal (towards the cheek) and lingual (or palatal, in the maxilla) are directions perpendicular to the line of the arch (Fig. 9). Apical refers to the direction towards the root apex (i.e. inferior in the mandible, superior in the maxilla), coronal towards the crown of the tooth. Similarly, the surfaces of a tooth may be mesial, distal, lingual (or palatal), buccal or occlusal (incisors have an incisive edge, rather than an occlusal surface).

Several numbering systems exist: the most widely accepted is that of the Fédération Dentaire Internationale, which uses a first digit to denote the quadrant (right maxilla, 1; left maxilla, 2; left mandible, 3; right mandible, 4) and a second digit to denote the tooth within that quadrant, numbering from mesial to distal. Thus, for example, the upper right lateral incisor is labelled 12 (pronounced ‘one two’, not ‘twelve’), the lower right second premolar 45 and so on. In this system, the deciduous teeth are distinguished by using the quadrant numbers 5–8 (in the same order); teeth in each quadrant are labelled 1–5 from mesial to distal. For example, the lower left deciduous second molar tooth is denoted as 75.

The mandible has a curved body, the halves of which join in the midline at the symphysis menti, and two posterior ascending rami, each with a superior coronoid process (anteriorly) and condylar process (posteriorly, ending in the condyle of the temporomandibular joint). The body and ramus meet at the angle. The inferior alveolar canal extends from the mandibular foramen on the medial aspect of the ramus to the mental foramen on the buccal surface of the body, opposite the second premolar. It carries the inferior alveolar nerve (a branch of the mandibular division of the trigeminal nerve) and vessels. The tooth-bearing body of the mandible, and the maxilla, consist of alveolar bone, which supports the dentition, and basal bone. Periodontitis and the edentulous state result in resorption of alveolar bone, such that in a patient who has been edentulous for years, only a thin rim of basal bone remains and the inferior alveolar canal may lie just beneath the surface of this bone (Fig. 10). The submandibular fossa is a depression for the submandibular salivary gland on the lingual surface of the distal mandibular body. Bone here may also have sparse trabeculae and together these factors can result in artefactual lucency in the distal body, which should not be mistaken for a lytic lesion (Fig. 11). Apparent
sclerotic lesions in the mandible may be due to lingual (mandibular) tori, which are exostoses on the lingual aspect of the anterior mandible, a common normal variant (Fig. 3). In the maxillary region, four white lines can be seen (Fig. 12): the hard palate, the floor of the maxillary sinus, the posterior wall of the maxillary sinus and the zygomatic buttress. The floor of the maxillary antrum often descends below the hard palate towards the alveolar crest: the inferior portion of the antrum between these two superimposed lines should not be mistaken for a periapical lucency. Molar, and occasionally pre-molar teeth, can project into the sinus floor, explaining the common association of mucosal thickening in the maxillary antrum with dental disease (Fig. 13).

**AN APPROACH TO THE DENTAL PANORAMIC TOMOGRAPH**

As with any technique, a brief check of name, date and orientation is followed by an assessment of technical quality. The standing dentition is counted and retained root fragments, supernumerary teeth and unerupted teeth are noted and described. Next, a search is made for caries, periodontal disease and periapical lesions. Osseous lesions are sought, described

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and analysed and the temporomandibular joints assessed for arthropathy. Review areas include the maxillary antra and hyoid bone and a search for soft tissue calcifications. A conclusion, summing up the major findings and answering the clinical question (if one was posed) ends the report.

**ABSENT, SUPERNUMERARY AND UNERUPTED TEETH**

Complete dentition may be present or the jaws may be partially dentate or edentulous. The dentition may be deciduous, mixed or permanent. Anodontia implies developmental absence of teeth: complete anodontia is rare, but partial anodontia is not uncommon, especially of third molars, mandibular second premolars (Fig. 11) and maxillary lateral incisors (Fig. 14). The commonest supernumerary tooth is the mesiodens in the anterior maxilla (Fig. 15) followed by supernumerary molar teeth, usually situated distal to the third molar (Fig. 16). The commonest unerupted teeth are third molars: the type of impaction is described relative to the occlusal plane (Figs 14, 17–19) and the root morphology and relationship to the inferior alveolar canal are also important.

**CARIES, PERIODONTAL DISEASE AND PERIAPICAL PATHOLOGY**

Dental caries result from the demineralization of the dental tissues by lactic acid produced by bacteria fermenting carbohydrates. The carious lesion has a varied radiographic appearance, depending on location and extent (Figs 20 and 21). Care should be taken to avoid mistaking radiolucent restorations or cervical burnout for caries (Fig. 22). The radiologist must also be aware that panoramic tomography is a relatively insensitive technique for detecting carious lesions, which are better seen on intraoral radiographs and many or most are clinically apparent.

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**Fig. 14.** Partial anodontia: the maxillary lateral incisors (12 and 22) are absent. Note also horizontal impaction of the mandibular third molars (38 and 48).

**Fig. 15.** Inverted mesiodens in the anterior left maxilla. There is an associated dentigerous cyst (arrows) and this causes displacement of the adjacent teeth.

**Fig. 16.** Cropped orthopantomogram showing a small supernumerary tooth (arrow) in the region of the upper right third molar (18) tooth.

**Fig. 17.** Patterns of third molar impaction. The lower left third molar (38) is unerupted with mesio-angular impaction. Its crown causes resorption of the distal root of 37. Mild disto-angular impaction of 48. Note also distal caries in 18.
Periodontitis is a common destructive process, secondary to chronic gingivitis, manifest radiographically by loss of alveolar bone. The earliest feature is localized erosion of the interproximal alveolar bone crest (Fig. 23). The distance between the cemento-enamel junction and the alveolar crest should generally be less than 1.5 mm. Alveolar bone loss can be horizontal or vertical and when severe may extend apically to the root furcation or to the apex. Calculus (calcified plaque) may coexist (Fig. 24).

Periapical inflammatory lesions can result from periodontitis (the periapical region forming part of the periodontium), or from spread of pulpitis (usually resulting from deep caries) through the root canal to the periapical region (Figs 13, 20 and 25). Ill-defined periapical lucency in the setting of deep caries or periodontitis is usually due to rarefying osteitis. Chronic inflammation may result in sclerosis (sclerosing osteitis) or a peripical granuloma, abscess or cyst (Fig. 26). A granuloma is small and well...
defined. Most well-defined periapical lesions larger than 10 mm are periapical (radicular) cysts.³

**SCLEROTIC OSSEOUS LESIONS**

The common sclerotic lesions found are periapical sclerosing (or condensing) osteitis and idiopathic osteosclerosis. The former is a manifestation of periapical inflammation, related to a non-vital tooth, often carious or heavily restored (Fig. 25). The latter is a common finding, often considered an enostosis or bone island, and like an enostosis elsewhere, it often has an irregular, ‘brush border’ margin (Fig. 27).⁶ These may be multiple in Gardner’s syndrome. Hypercementosis is excessive deposition of cementum on the tooth roots, usually idiopathic. It is asymptomatic, but may be seen in Paget’s disease and with acromegaly.⁷ It can result in difficulty if extraction is indicated. The excessive cementum is encompassed by the lucent periodontal ligament space, an important diagnostic feature (Fig. 28).

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**Fig. 23.** Early periodontitis. There is mild horizontal alveolar bone loss, with blunting of the alveolar crest between the anterior teeth, and rounding of the junction between the crest and the lamina dura.

**Fig. 24.** Cropped orthopantomogram showing moderate, generalized horizontal bone loss secondary to periodontitis. There is also vertical periodontal bone loss between 22 and 23, mesial to 27, and extending to the root bifurcation of 37 and almost to the apex of the mesially impacted 38. A tiny focus of calculus is present mesial to the 38 crown.

**Fig. 25.** Extensive sclerosing osteitis within the mandible. The periapical lucency around 45 results from severe vertical periodontitis. The periapical lucencies at the restored, root-filled 36 tooth have spread from the pulp through the root canals.

**Fig. 26.** Small periapical abscess related to the heavily restored lower right second molar tooth (47).

**Fig. 27.** Cropped orthopantomogram showing a focus of idiopathic osteosclerosis related to the mesial root of the lower right first molar tooth (46), which is neither carious nor restored.

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OTHER FINDINGS

Inflammatory disease, including mucosal thickening and post-inflammatory retention cysts, are commonly seen in the maxillary antra. There may be evidence of osteoarthritis in the temporomandibular joints (Fig. 28). Postinflammatory calcification is often seen in the faucial tonsils (Fig. 19) and calculi may be seen in the submandibular gland (Fig. 29).

CONCLUSION

An approach to the OPG has been presented, together with an overview of technique, artefacts and errors and illustration of some of the more commonly seen pathology. There are many odontogenic and non-odontogenic lesions of the jaws, beyond the scope of this pictorial review, but these are easier to approach with a simple framework for analysis of the OPG.

REFERENCES