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Pictorial Review

DentaScan in Oral Imaging

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In the past, dental disease and lesions involving the jaw were either evaluated by plain radiography or tomography. The advent of spiral computed tomography (CT) and DentaScan is changing the imaging trend. It is now not only used for pre-implant assessment but also in the diagnosis of lesions affecting the jaw. This pictorial review discusses the role of DentaScan in the various abnormalities that may affect the mandible and maxilla. Au-Yeung, K. M. *et al*. (2001). *Clinical Radiology* **56**, 700–713.

Key words: DentaScan, oral pathology/computed tomography.

DentaScan is a computed tomography (CT) software program that allows the mandible and maxilla to be imaged in three planes: axial, panoramic and cross-sectional. It has been widely used pre-operatively for implant surgery as it provides a comprehensive assessment of the morphology and measurement of the dental implant. Introduced in the mid-1980s, DentaScan offered improvements in the evaluation of the osseous mandible and maxilla and has been reported to be useful in head and neck surgery [1–3]. We have explored the clinical usefulness of DentaScan in various oral lesions, other than mandibular implants.

IMAGING TECHNIQUES

All patients in this study were imaged using helical CT (High Speed Advantage, General Electric Medical System, Milwaukee, WI, U.S.A.). Since the DentaScan program does not permit angulation of the gantry, it is essential that the patient is properly positioned so that true axial images are obtained. During CT, the patient should remain motionless. If both the mandible and maxilla are being evaluated, a separate run should be performed for each because the axial plane of the mandible is different from that of the maxilla. From the preliminary lateral scout view, the upper and lower limits of the study and the scan plane parallel to the alveolar ridge for either maxilla or mandible should be defined. Axial CT with 1 mm contiguous slices is performed using a bone algorithm, dynamic mode, 15A cm field of view, 512×512 matrix, 140 kV and 70 mA. The data is transferred to the workstation for post-processing.

The actual data acquisition time for maxilla or mandible is about 15 min. From the workstation and using the axial scan data, a curved line along the midportion of the alveolus is created on an axial image of the mandible or maxilla. The axial image chosen should be at the level of the roots of the teeth and demonstrate the full contour of the mandible and maxilla [4]. The curved line defines the plane and location of the reformatted panoramic images. It also marks the beginning and the end of the cross-sectional images. The program, which is provided by General Electric (GE, Milwaukee, WI, U.S.A.), then automatically reformats the images.

When the reconstruction is complete, three sets of images are displayed: axial, cross-sectional, and panoramic. Typically there are approximately 30–50 axial images, 40–100 cross-sectional images, and five panoramic images. It should be noted that each CT view can be related to the other by a series of scale marks that appear on the films. Marks, which run along the side of the cross-sectional and panoramic images, correspond to the direct axial slices that are used to reformat the images. Marks along the bottom of the panoramic images correspond to numbered cross-sectional images. A millimeter scale displayed on the bottom of the cross-sectional films is used to verify the degree of magnification and to obtain accurate measurements.

The effective dose of the standard DentaScan Protocol is around 8.16 mSv. The DentaScan is not free from artefact,

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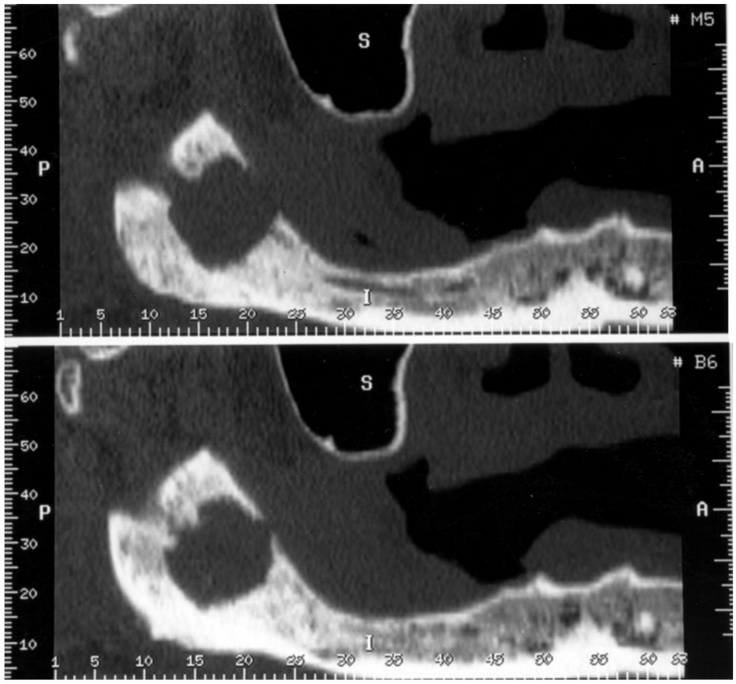

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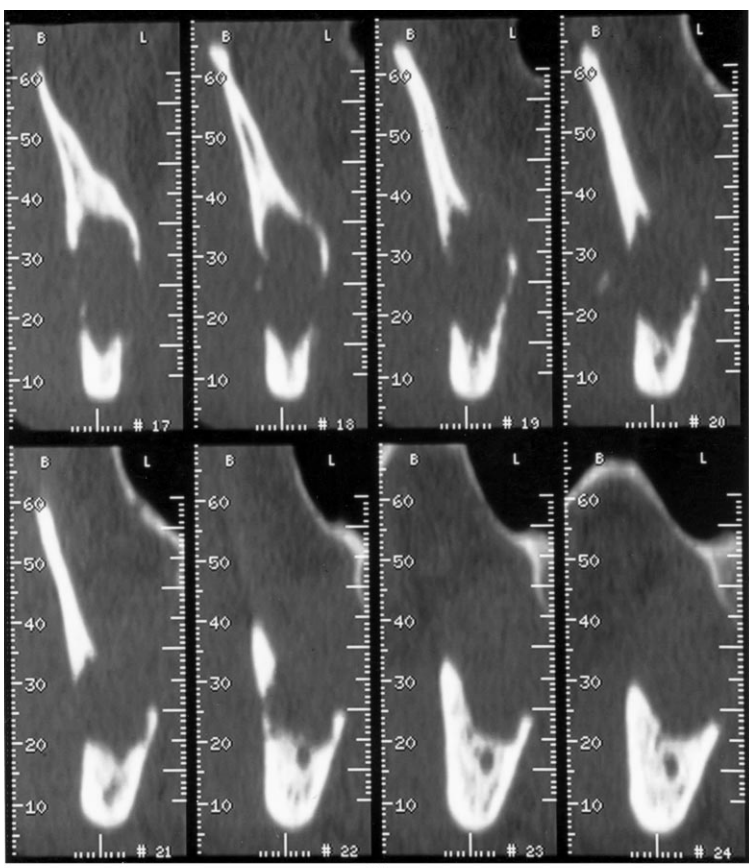

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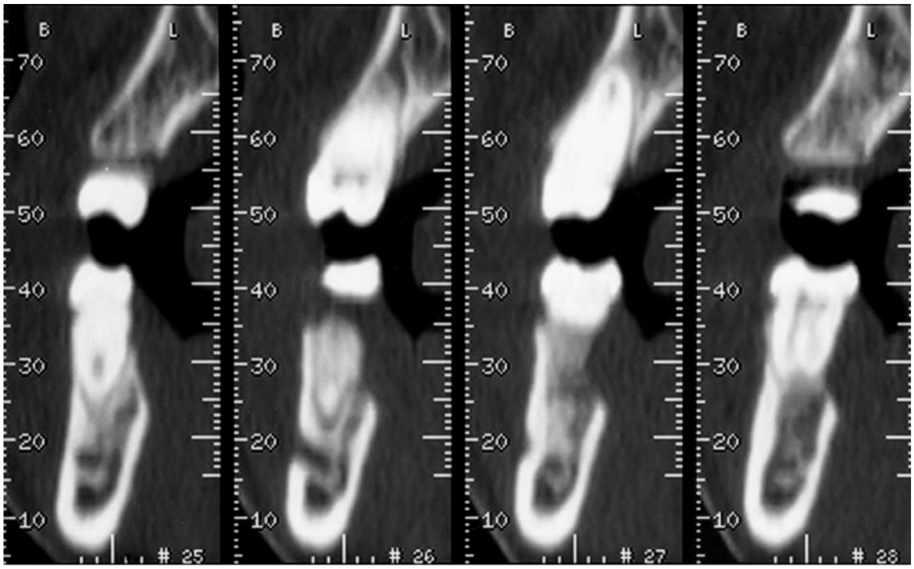
Fig. 1 – Mandibular erosion by a retromolar trigone squamous cell carcinoma (SCC). In a DentaScan series of (*a*) panoramic and (*b*) cross-sectional views, the mandible is edentulous with bony destruction of the angle of right mandible and soft tissue thickening in the panoramic and cross-sectional view. The mandibular canal is preserved but the mandibular foramen is destroyed as seen in the cross-sectional view. Biopsy confirmed the presence of retromolar invasive SCC with bony erosion.



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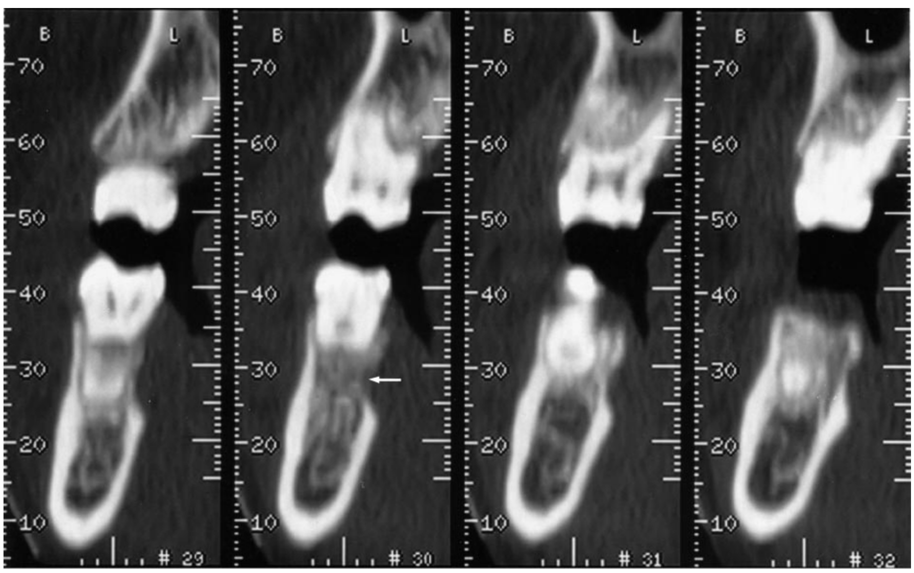

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Fig. 2 – Oral SCC with mandibular erosion. Pre-operative DentaScan (*a*) and (*b*) contiguous cross-sectional views show subtle focal cortical thinning in the upper lingual aspect of the left mandible (arrow b). The tooth is intact. The site is adjacent to the oral SCC. At surgery, the corresponding bony cortex was found to be eroded by the tumour.

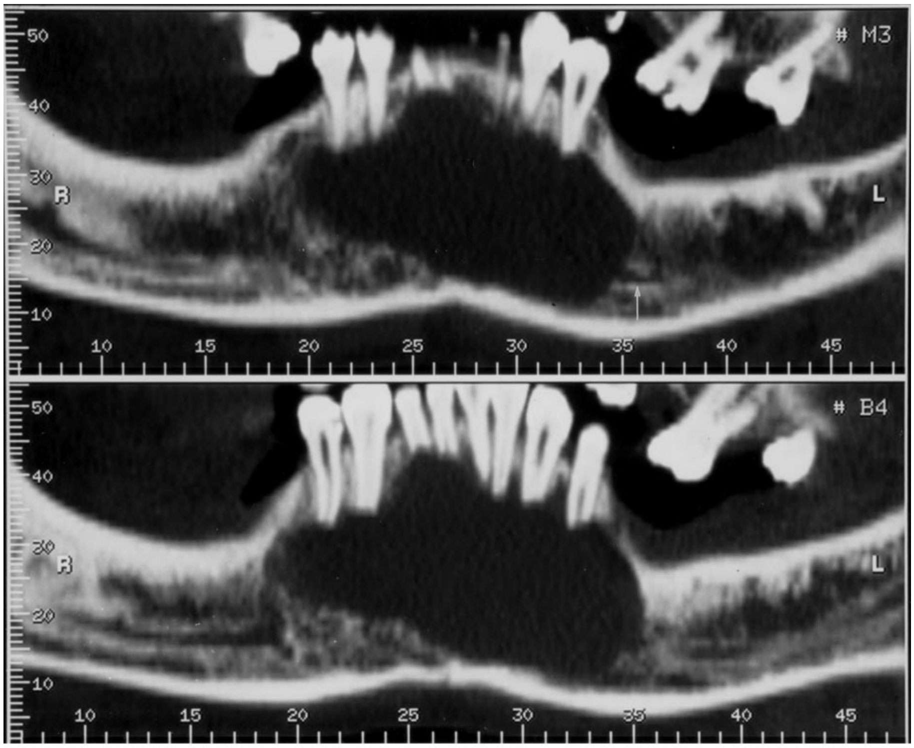
particularly that due to motion. Some patients may have amalgam fillings in their teeth. Since the fillings are above the jaw bone, the artefact casted by amalgam would be minimal and not affect the quality of images. Similarly, root-canal procedures and bridgework above the jaw bone have a minimal effect on image quality.

PATHOLOGY

Squamous Cell Carcinoma of the Oral Cavity

Only 7% of oral cavity lesions are malignant and SCC accounts for 90% of the tumours [5]. Most masses within the oral cavity, both benign and malignant, are amenable to direct clinical examination. The primary purpose of imaging is to detect deep or submucosal extent and adjacent osseous involvement. Bony erosion is better characterized by multi-planar CT (Fig. 1).

Unlike standard pantomography, there is no superimposition of other osseous structures in DentaScan. The image quality is sharp and clear, providing better tissue contrast resolution. Anatomic structures such as the inferior alveolar canal, mental foramen, mandibular foramen, buccal and lingual cortical margins, and the wall of the maxillary sinus can be clearly identified and evaluated. It is essential to evaluate the mandible in



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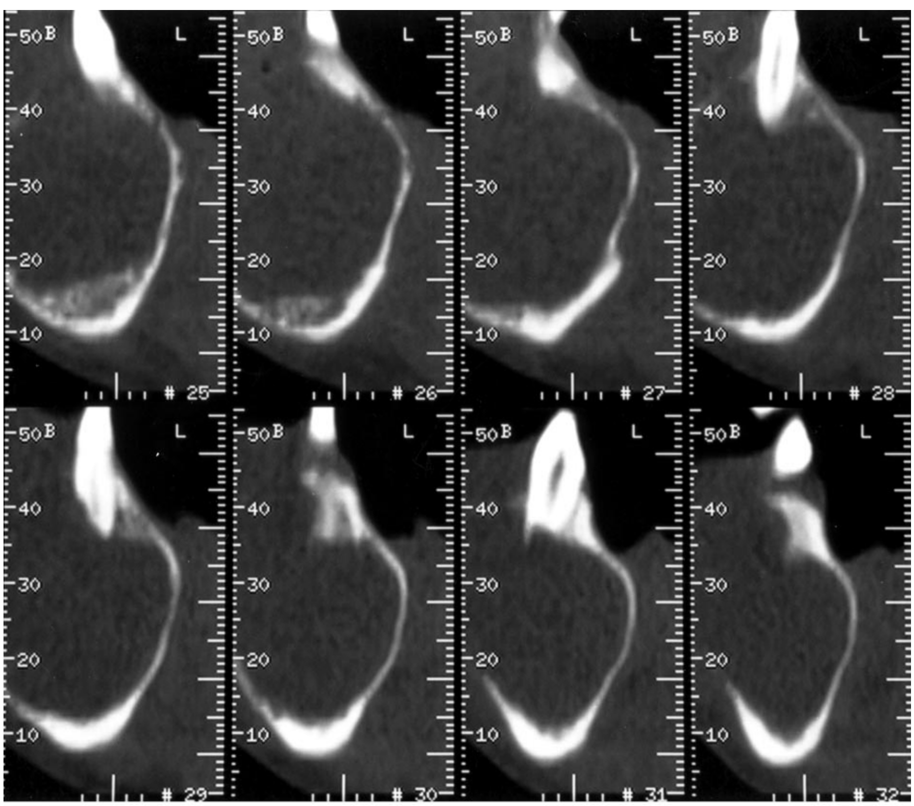

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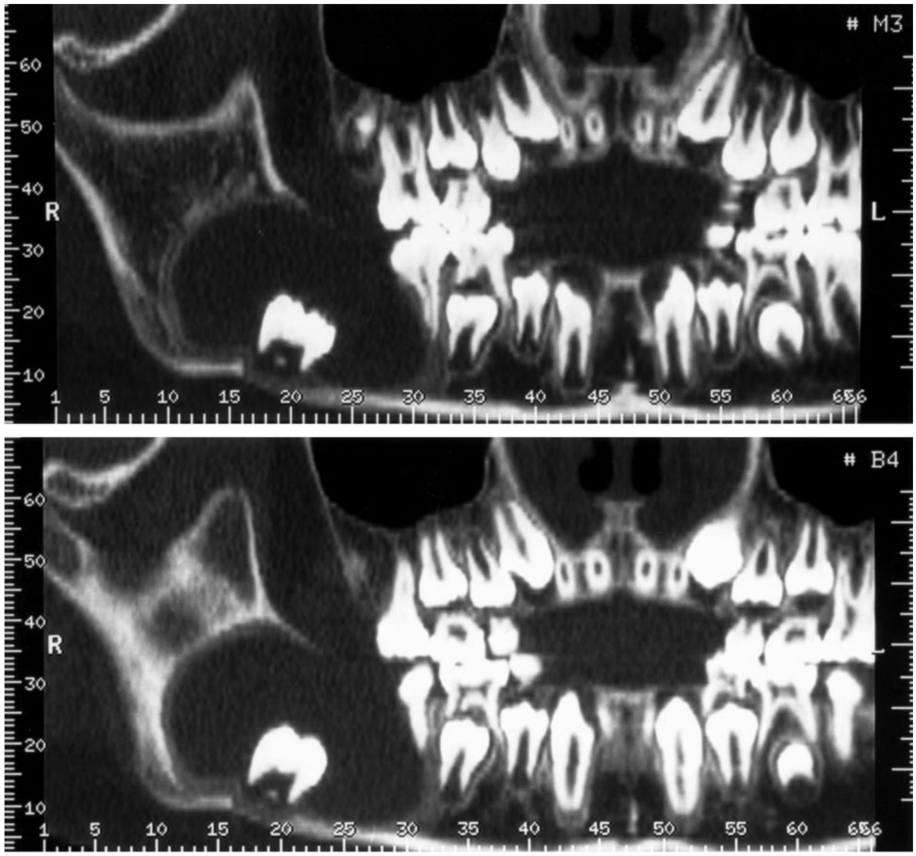
Fig. 3 – Ameloblastoma. The DentaScan (*a*) panoramic and (*b*) cross-sectional views show a well-defined, expansile, osteolytic lesion in the mental region of the mandible. The overlying cortex is thin. The root of the incisor and canine have been cut sharply by the lesion, which erodes the left distal mandibular canal and mental foramen (arrow *a*). Biopsy confirmed the diagnosis of ameloblastoma.



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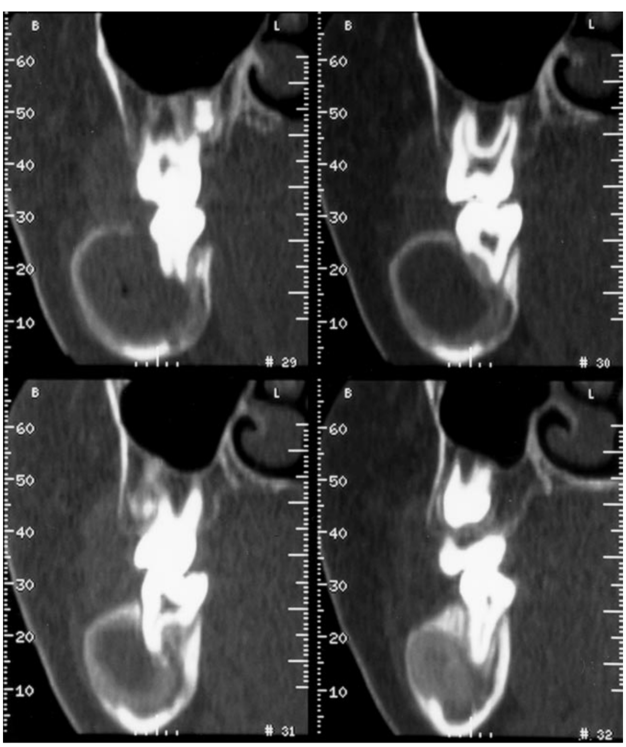

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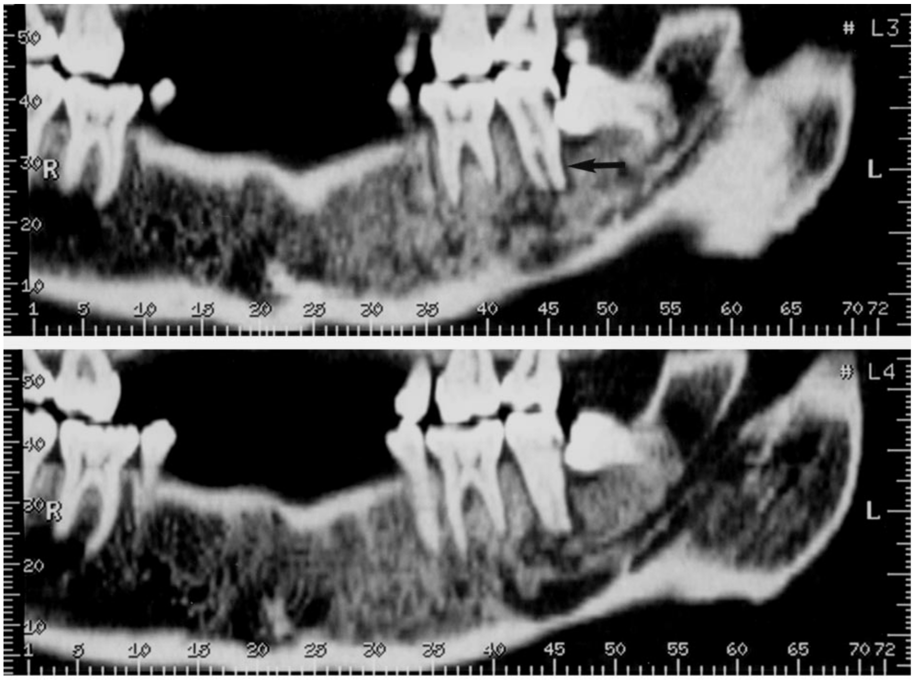
Fig. 4 – Ameloblastoma within a dentigerous cyst. The (*a*) panoramic and (*b*) cross-sectional views of the DentaScan show a well-defined unilocular cystic lesion in the angle of right mandible. Unerupted molar tooth is present in the cystic lesion. The rest of the teeth are displaced by the cystic lesion. The appearances are suggestive of a dentigerous cyst. Surgical excision of cyst was performed which reveals the presence of ameloblastoma inside the cyst. The final pathological diagnosis was a unicystic ameloblastoma, probably arising from a dentigerous cyst.



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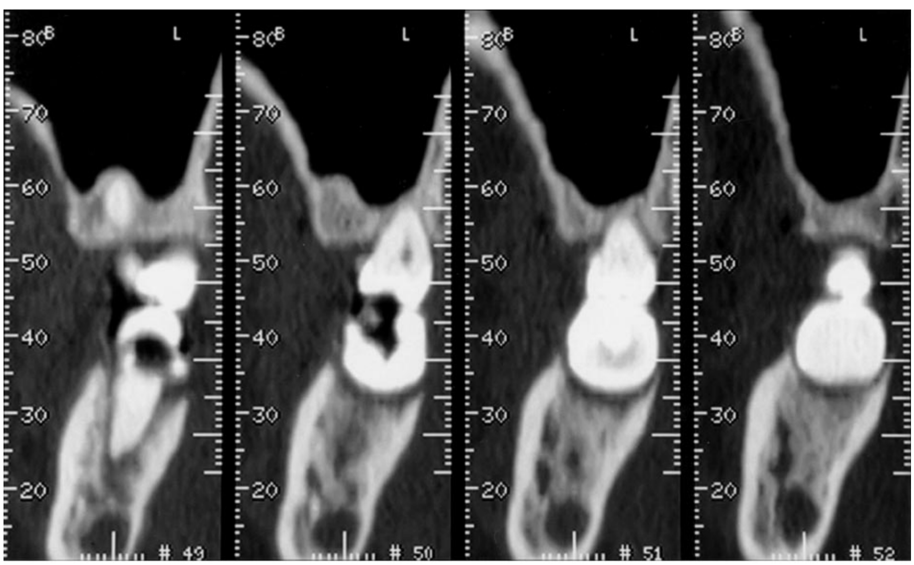

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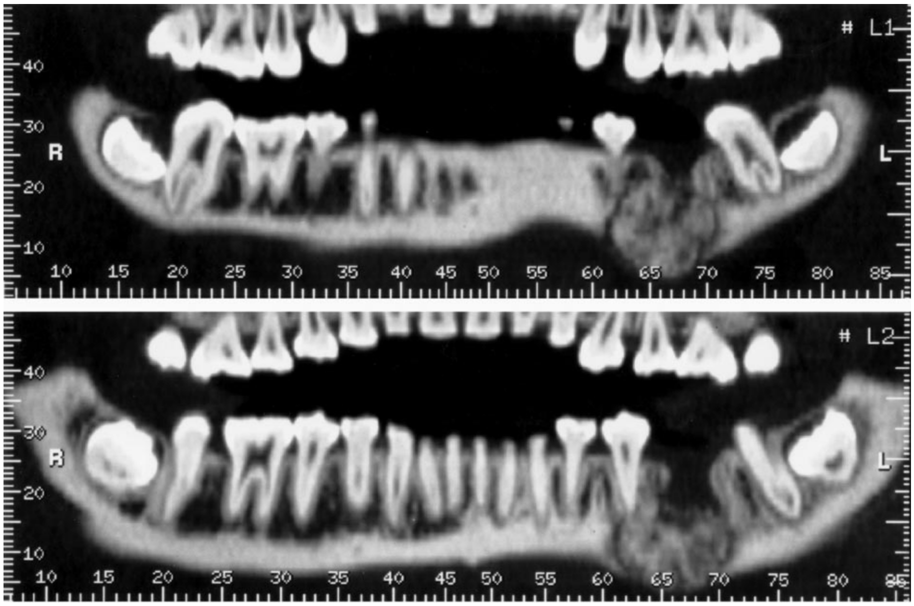
Fig. 5 – Osteogenic sarcoma. DentaScan (*a*) panoramic and (*b*) cross-sectional views show ill-defined sclerosis of the left mandible extending to the symphysis menti. The cross-sectional view also demonstrates the multifocal hypodensities in the sclerotic mandibular medulla. No cortical break or periosteal thickening was noted. Interestingly, the periodontal space of the left premolar and molar are slightly widened with floating tooth appearance (arrow, *a*). Biopsy confirmed osteogenic sarcoma.

these cases as it affects patient management. Radiotherapy can be used if there is no bone involvement, whereas involvement of the mandible (19–26% of oral cavity carcinomas) [6–8] usually requires mandibular resection. On cross-sectional views in DentaScan, buccal and lingual cortical involvement is clearly identified (Fig. 2). These views provide the surgeon with better pre-operative information in relation to the extent of resection and patient counselling.

Ameloblastoma

Ameloblastoma accounts for about 1% of all tumours and cysts of the jaws. The mandible is involved in about



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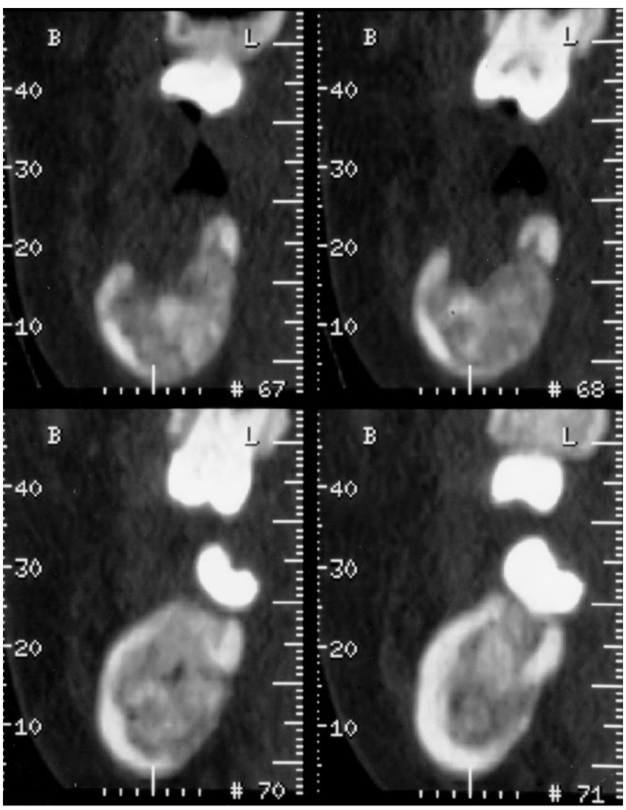

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Fig. 6 – Cementoblastoma. DentaScan (*a*) panoramic and (*b*) cross-sectional views show a well-defined expansile, ground-glass lesion with a radiolucent halo in the left body of the mandible. The panoramic view shows the loss of the left second premolar and left first molar teeth. The cross-sectional views depict the relation of the teeth with the ground-glass lesion. The lingual bony cortex is lost and probably due to pressure-erosion by the lesion. The lesion appears benign in appearance and found pathologically to be a benign cementoblastoma.

80% and the maxilla in 20%. The distal ascending ramus and molar regions are most commonly affected. Although pantomography was often used for assessment of this tumour in the past, DentaScan now provides a better evaluation of the lesion. Features suggestive of an ameloblastoma are a well-circumscribed, expansile, low attenuation lesion with cortical resorption (Fig. 3). The tumour may be unilocular (Fig. 4) or multi-locular. A unilocular ameloblastoma usually occurs in younger patients (usually between 20 and 30 years) and is located in the mandibular molar region (Fig. 4) whereas the multilocular tumour affects patients between 3rd and 7th

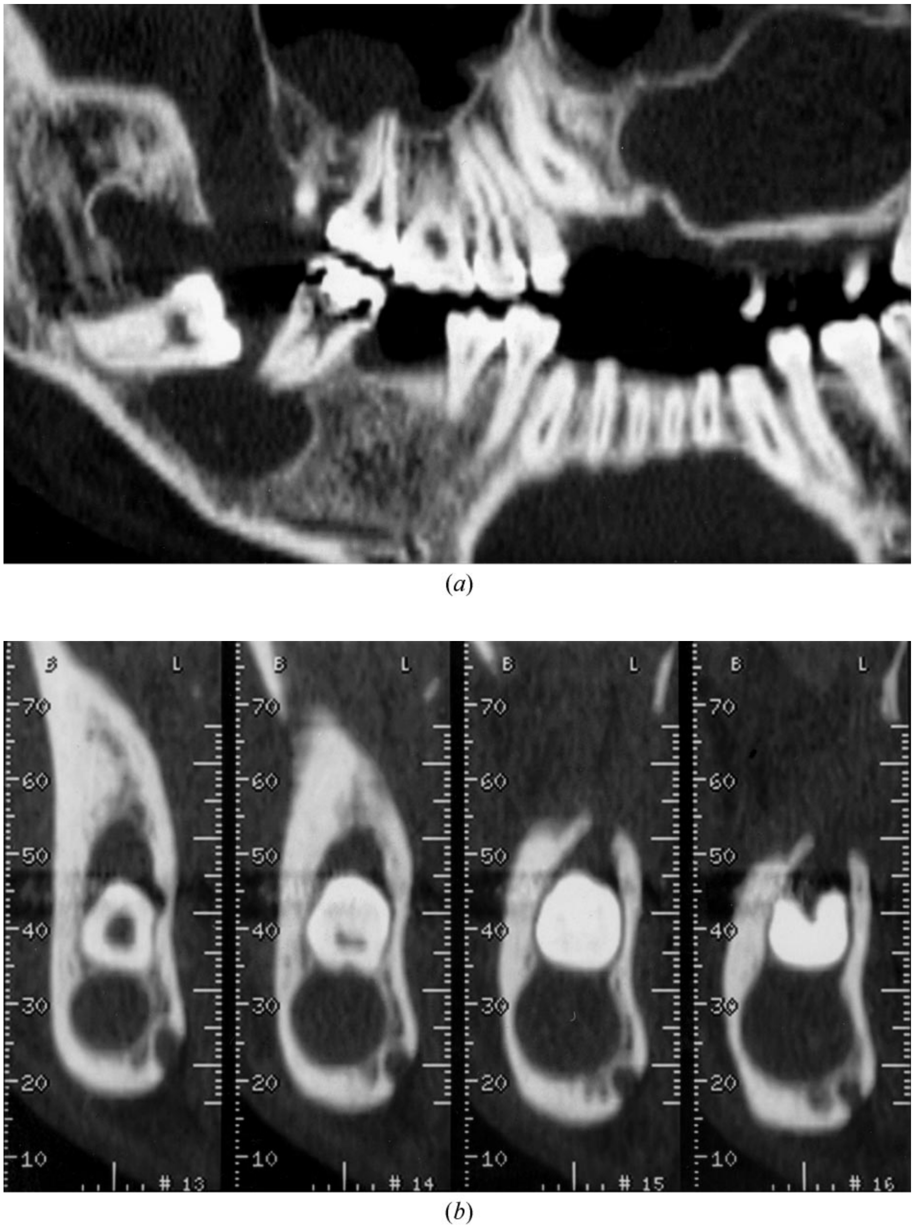

Fig. 7 – Dentigerous cyst. DentaScan (*a*) panoramic and (*b*) cross-sectional views shows the impacted third molar tooth at the angle of right mandible, which is encircled by an sharply marginated, expansile cyst. Features are of a dentigerous cyst.

decade of life [9], and involves the mandible and maxilla with equal frequency.

Osteogenic Sarcoma

Osteogenic sarcoma is the most common malignant tumour of the mandible. It is less aggressive than osteogenic sarcoma of the long bones. Mortality is often due to local persistence or intracranial extension. Osteogenic sarcoma of the facial bones occurs most often in patients between 30 and 39 years. The radiographic [10] and CT findings are variable and non-specific. Some indicate an aggressive neoplastic process and some may show the presence of a mineralized osteoid or chondroid matrix associated with bone destruction, periosteal reaction, and a soft-tissue mass. Other features include the ‘floating tooth’ resulting from resorption of bone around a root (Fig. 5).

Mandibular Cementoblastoma

Cementoblastoma is a rare benign neoplasm of functional cementoblasts, which is characterized by the formation of a cementum or cementum-like mass connected with a tooth root. The teeth commonly affected are in the pre-molar–molar region of the jaws, and the lesion may disrupt the tooth innervation by surrounding the root apex. As a result,

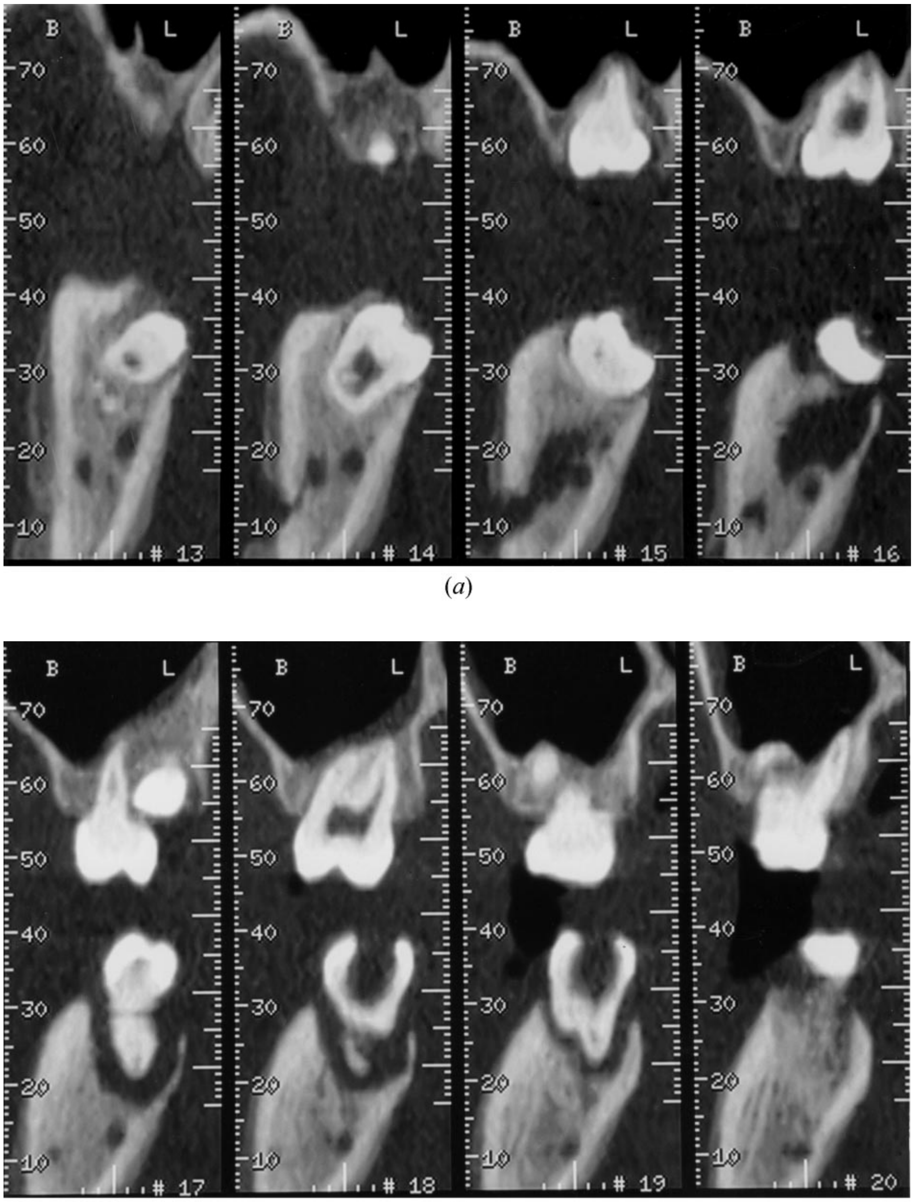

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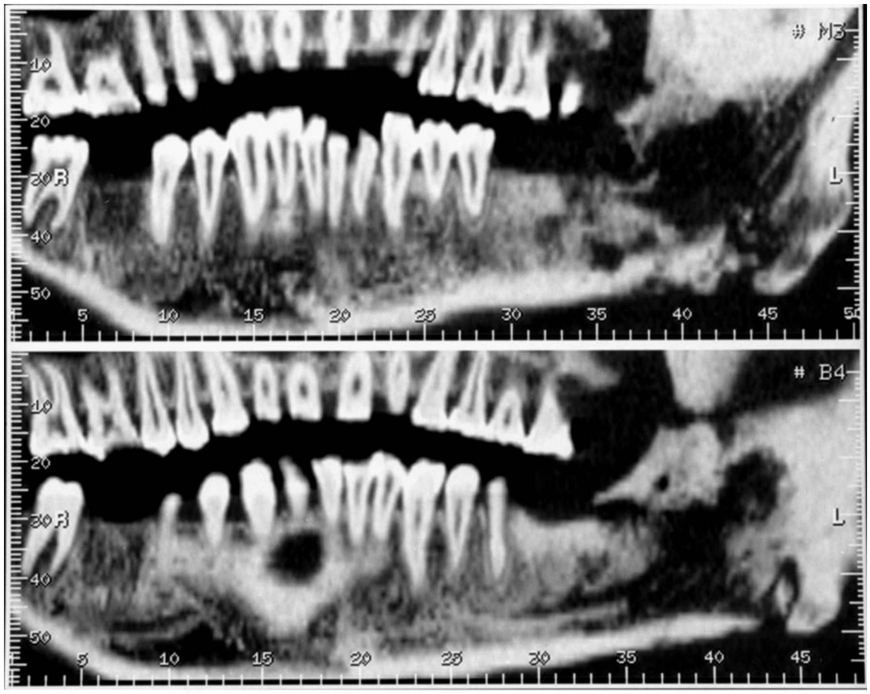
Fig. 8 – Mandibular osteomyelitis. In the angle of right mandible, the contiguous cross-sectional view (*a*) and (*b*) of the DentaScan show multi-focal ill-defined 'moth-eaten' hypodensities against a sclerotic background. Periosteal thickening is visualized in the buccal and lingual aspect of the mandible. There is also an empty socket of the second molar due to dental infection. DentaScan suggests mandibular osteomyelitis arising from the dental infection. Biopsy confirmed the presence of acute and chronic inflammation with Gram-positive rods.

many of the involved teeth are not viable [11]. The lesion occurs most frequently in men under 25 years of age. The tumour is commonly solitary and the mandibular first molar is the most frequently involved region. On plain radiography and pantomogram, the lesion is well defined, with central radiopaque material, is attached to the tooth root and a surrounding radiolucent zone of uniform width, which represents the peripheral unmineralized tissue. We could find no previous report of the appearance of a cementoblastoma on a DentaScan. The DentaScan findings were similar to those on plain radiography (Fig. 6). Surgically, the lesion is easily enucleated since it is benign and is surrounded by a capsule.

Dentigerous Cyst

A dentigerous cyst is the second most common odontogenic cyst, occurring most often in the mandibular third molar or maxillary cuspid regions. The cysts result from the cystic degeneration of the enamel organ after partial or total development of the crown [9]. Plain films demonstrate an expansile radiolucent lesion associated with a crown or



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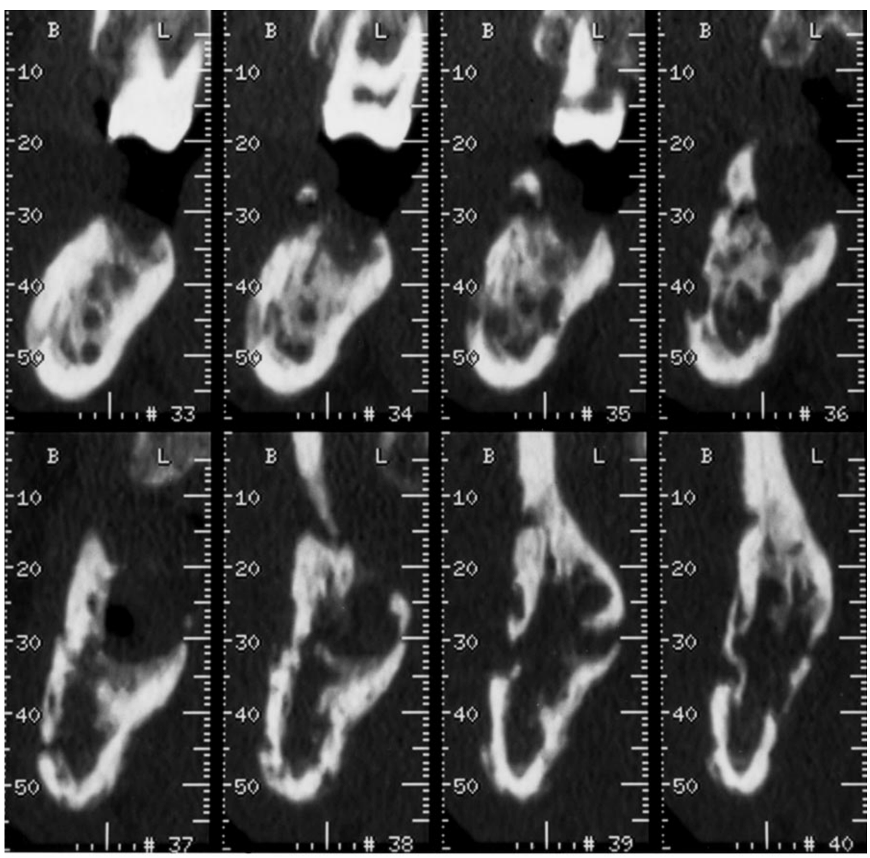

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Fig. 9 – Post-radiation-induced osteo-radionecrosis. DentaScan (*a*) panoramic and (*b*) cross-sectional views of a patient with history of previous radiotherapy for tonsillar carcinoma show an edentulous left mandible. There is a heterogeneous low-attenuation area seen against a sclerotic background of the left mandible. The cross-sectional and panoramic views demonstrate that the involvement of the left mandibular foramen and canal by the lesion. Cortical thinning and break are also identified in the buccal aspect. Biopsy of the left mandible confirmed the diagnosis of post-irradiation ostenonecrosis.

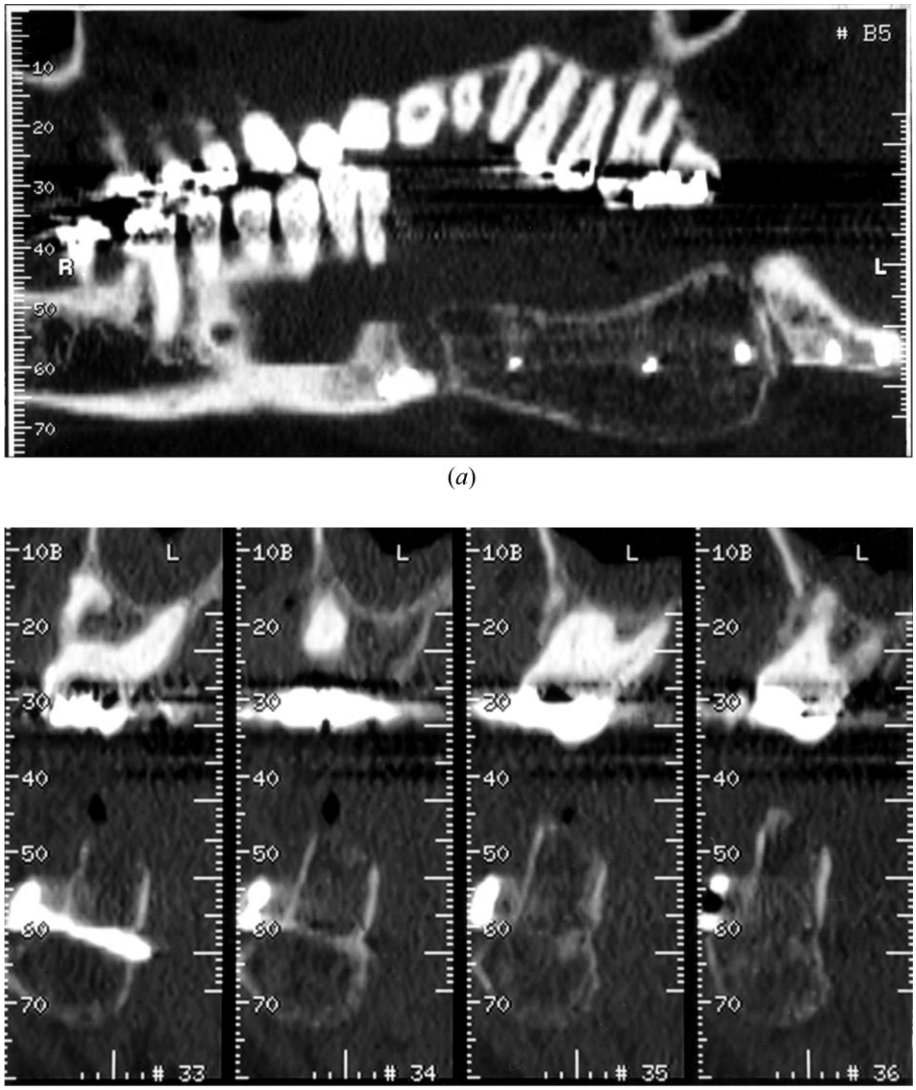

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Fig. 10 – Graft evaluation. A 57-year-old patient with gingival carcinoma with left hemimandibulectomy and iliac crest microvascular bone graft performed. The post-operative DentaScan (a) panoramic and (b) cross-sectional views show the alignment of the graft in cross-sectional, panoramic and axial views. The depth of the metallic nail and the anatomotic sites can be evaluated.

unerupted tooth. Cortical expansion is usually present at diagnosis. Because of its multiplanar capability, these lesions are better demonstrated and evaluated by a DentaScan (Fig. 7).

Chronic Infection

Chronic osteomyelitis, a persistent infection of bone, has two forms: chronic sclerosing osteomyelitis and chronic suppurative osteomyelitis. Abscess formation, subtle periosteal reaction, and sequestration of the non-viable bone due to suppurative osteomyelitis are well demonstrated by DentaScan (Fig. 8).

Post-operative or Post-Radiotherapy Assessment

SCC of the oral cavity may be treated by either surgical resection or radiotherapy. In clinical practice the presence of tumour recurrence or radiation-induced necrosis is a common dilemma and a biopsy is indicated to make a definitive diagnosis. However, complete assessment of the jaw lesion (change in density, cortical break or presence of soft tissue component) is useful for evaluating recurrence. DentaScan provides this information in different planes, and also shows the presence of the soft tissue component (Fig. 9). Surgical treatment consists of mandibulectomy and bone grafting. DentScan demonstrates the alignment of the graft in

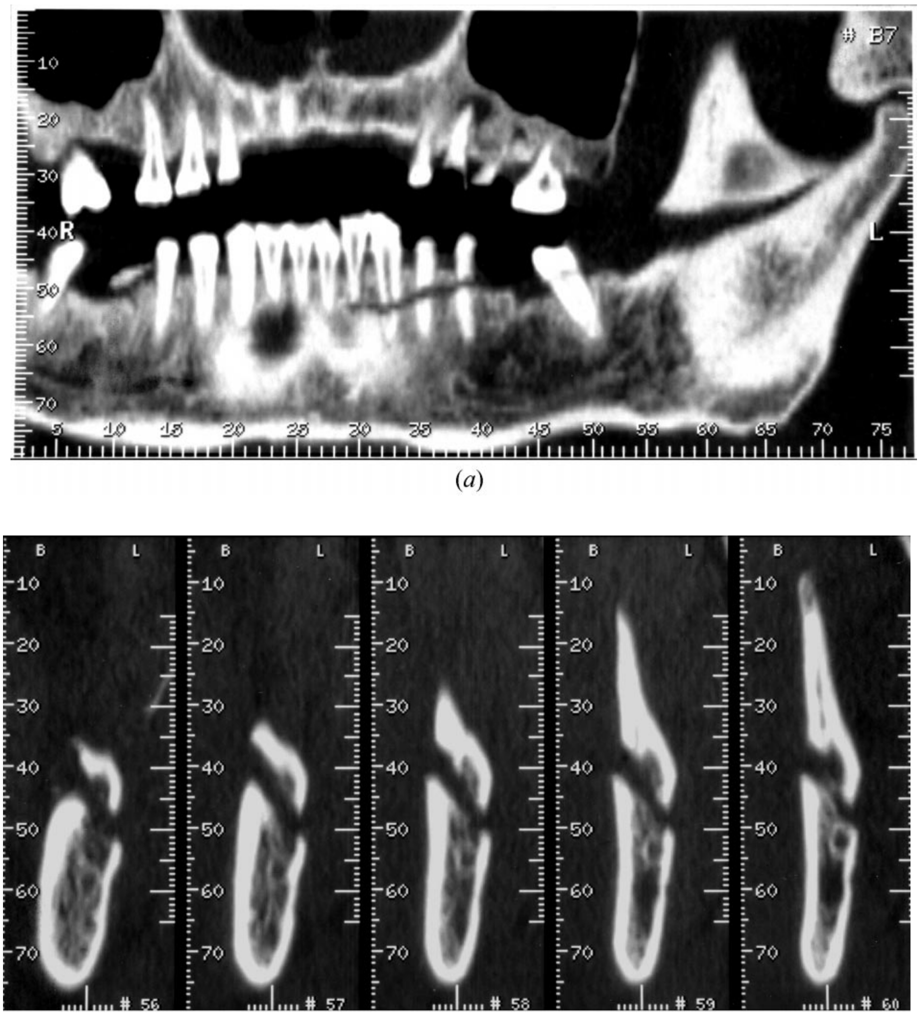

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Fig. 11 – Trauma. The (*a*) panoramic and (*b*) cross-sectional views on a DentaScan identify a well defined linear lucency cut with separation of fragment involving the root of left canine, left premolar and left molar teeth. The fracture extends to the coronoid process of the left mandible resulting in the displacement of fragments. The left mandibular foramen and canal are intact.

multiple planes, which is crucial for surgical assessment (Fig. 10).

Trauma

Because of its multi-planar capability, DentaScan is extremely useful in the evaluation of trauma. Proper assessment of the site, extent and orientation of the fracture is possible before surgery (Fig. 11).

Congenital Hyperplasia of the Condyle

Developmental bilateral mandibular hyperplasia is an uncommon anomaly. Asymmetry of the mandible is a frequent clinical presentation. The most prominent facial features include a shift of the chin to the short side and prominence of the mandibular angle on the long side. In many cases, the cause of mandibular asymmetry leading to facial deformity is unclear on physical examination and imaging assessment is warranted [12,13]. Imaging is performed to exclude other causes (such as trauma) and for treatment planning. Although pantomography and magnetic resonance imaging (MRI) have been used for depicting the condyles, the panoramic view on DentaScan provides better evaluation of the bony process (Fig. 12).

Phakomatoses

Neurofibromatosis type 1 (NF1), or von Recklinghausen disease, is the most common form of phakomatosis. Phakomatoses are genetic disorders with abnormal neuroectodermal and mesenchymal proliferation leading to neoplastic or hamartomatous lesions in the central and peripheral nervous systems, as well as in the skin. Osseous craniofacial abnormalities occur rarely compared to the axial or peripheral skeletal manifestations. The spectrum of imaging

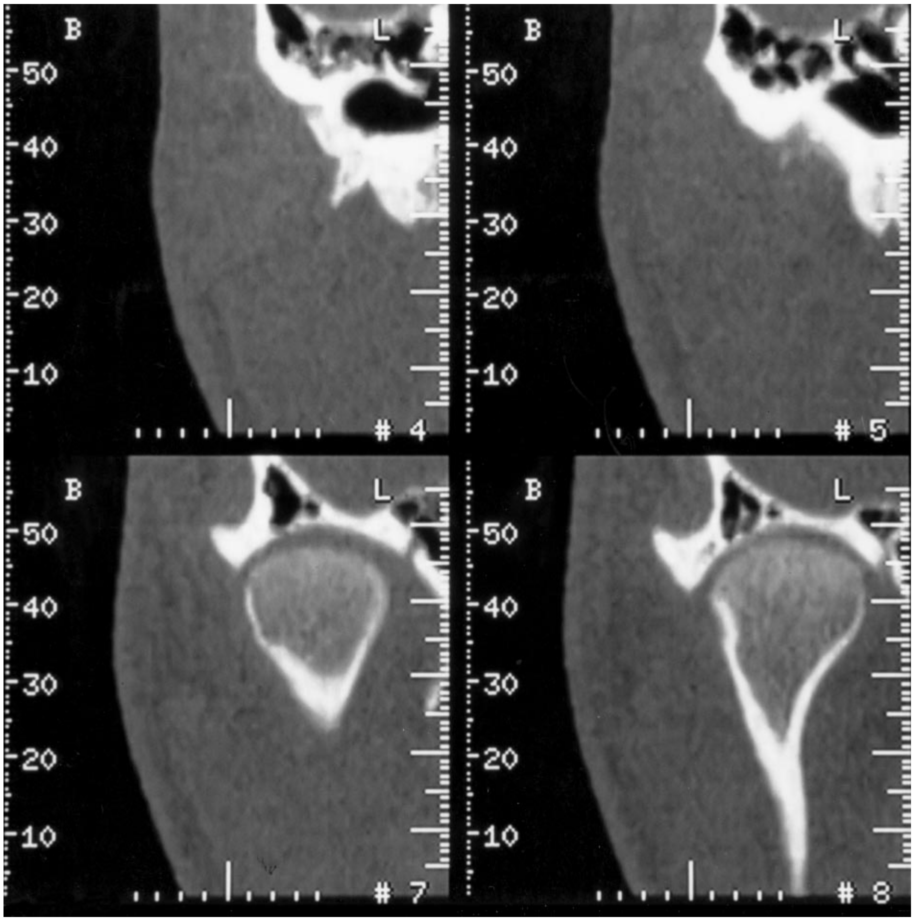

Fig. 12 – Prominent condylar head. The cross-sectional view of the DentaScan of 18-year-old man shows the prominence of the condylar head. No marginal osteophytes or joint erosion is seen. Bone scintigraphic examination revealed the condylar head had twice the tracer uptake compared to the adjacent cranium.

features is wide, including calvarial defects, dysplastic sphenoid, changes in the sella turcica and orbit, mandibular changes and enlargement of neural foramina [14,15].

Imaging plays a major role in screening, follow-up and treatment of the patients with NF1. DentaScan provides essential information in patients who require craniofacial plastic surgery, in particular those cases requiring jaw reconstruction. Panoramic views provide a better profile of bony abnormalites ranging from a slender coronoid process, an obtuse mandibular angle, hypoplasia of the body or ramus to enlarged mandibular, or mental foramina secondary to inferior alveolar nerve involvement. Multiple cross-sectional images of the mandible can reveal unerupted or malpositioned teeth associated with a cystic cavity [15,16] and provide detailed dental measurements (Fig. 13).

CONCLUSION

As CT is widely available, DentaScan can play a wider role in evaluating lesions of the mandible and maxilla. It provides valuable information in the assessment of oral cavity tumours (pre-and post-operative, post-radiotherapy); lesions of the jaw (benign and malignant, infection) and bony anatomy before and after implant surgery.

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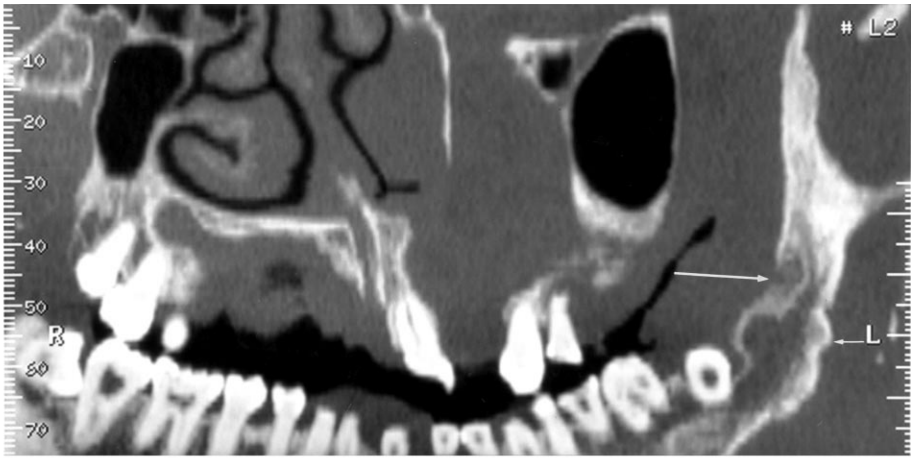

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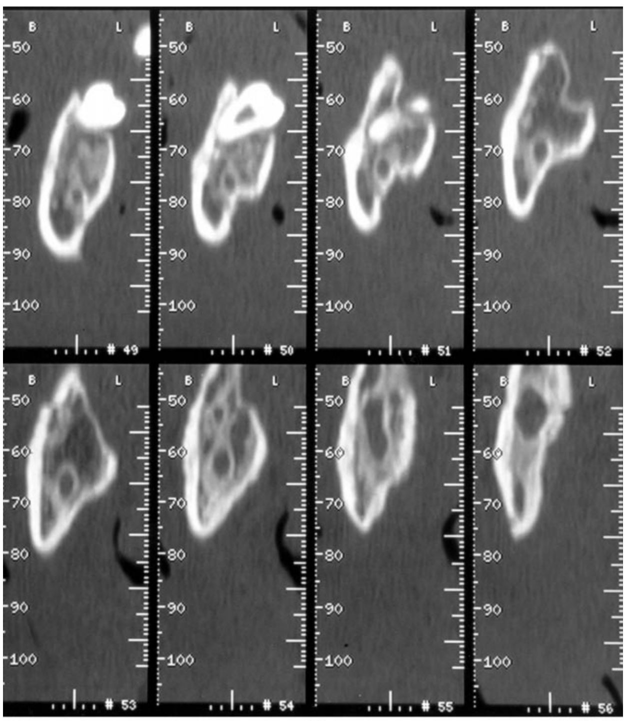

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Fig. 13 – Phakomatoses. Dentascan (*a*) panoramic (*b*) cross-sectional views in a patient with NF1. Panoramic views show marked hemi-hypoplasia of the left mandible. There was associated dislocation of the temporomandibular joint and malocclusion (not shown on these images). Thinning and remodelling of the condylar process and coronoid process associated with a 'wide mouth' notch are noted. The mandibular angle is obtuse and a rudimentary bony protuberance is noted (small arrow). Note the enlarged mandibular foramen (long arrow), unerupted left third molar and impacted right third molar. The enlargement of the inferior alvelolar canal is better seen on cross-sectional images.

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