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SHORT COMMUNICATION

Clinical indications for digital volume tomography in oral and maxillofacial surgery

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Digital volume tomography (DVT, NewTom, NewTom AG, Marburg, Germany) is a novel technique for maxillofacial imaging at a lower radiation dose and lower cost than CT. We describe four clinical cases to illustrate its potential advantages.
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Introduction

Three-dimensional imaging techniques such as CT or MRI imaging have become increasingly important in diagnostic imaging in the head and neck.[1] CT involves, however, a considerably higher radiation dose[2] than conventional radiography as well as higher operating costs and a significant investment in equipment.[3] Digital volume tomography (DVT) is a new imaging technique which produces similar three-dimensional images to CT but at a radiation dose comparable with panoramic radiography and at lower cost.[4] In this preliminary communication we describe four examples of its clinical application.

Techniques

Digital volume tomography (NewTom Model QR-DVT 9000, NewTom AG, Marburg, Germany) has been routinely used in the Department of Oral and Maxillofacial Surgery, University of Heidelberg since December 1999 (Figure 1). This device has an X-ray tube that can be rotated by 360° with a maximum output of 110 kV and 10 mA, 0.7 mm A1-equivalent filtration and a constant 14° cone beam angle. The detector consists of an image intensifier with an 8×8 inch-input window with an intensification factor of 22 : 1. Image recording is made with a CCD-chip with a matrix of 752×582 pixels.

The initial data is obtained by rotating the X-ray tube and the image intensifier through 360° around the stationary patient. One separate sagittal image is obtained per degree and in one 76 s cycle a symmetric volume 10 cm in height and 12 cm in diameter is captured. The average absorbed dose is 6 mSv (according to the manufacturer) per complete cycle using 'smart-beam technique' in order to achieve maximum dose reduction. The 94 MB initial data is presented as a lateral tomogram, from which the layer thickness of the layers to be reconstructed (0.3; 1.0; 3.0 mm) and the reconstruction angles are determined. Image processing is with dedicated reconstruction software (NewTom 9000 Dental) operating under Windows NT. After this primary reconstruction, further secondary reconstructions, such as sagittal, coronal and para-axial cuts and 3D-reconstructions can be generated.

Case reports

Case 1:
A 45-year-old man sustained multiple comminuted fractures of his mandible in a traffic accident. The panoramic radiograph (Figure 2) showed fractures in the right mandibular angle as well as in the left canine-premolar region. However, the fractures were poorly visualised and the anterior part of the mandible as well as the temporomandibular joints could not be assessed. Therefore further imaging was necessary. In the axial DVT view (Figure 3a), both fractures are clearly seen. The 3D-reconstruction (Figure 3b) also demonstrates a

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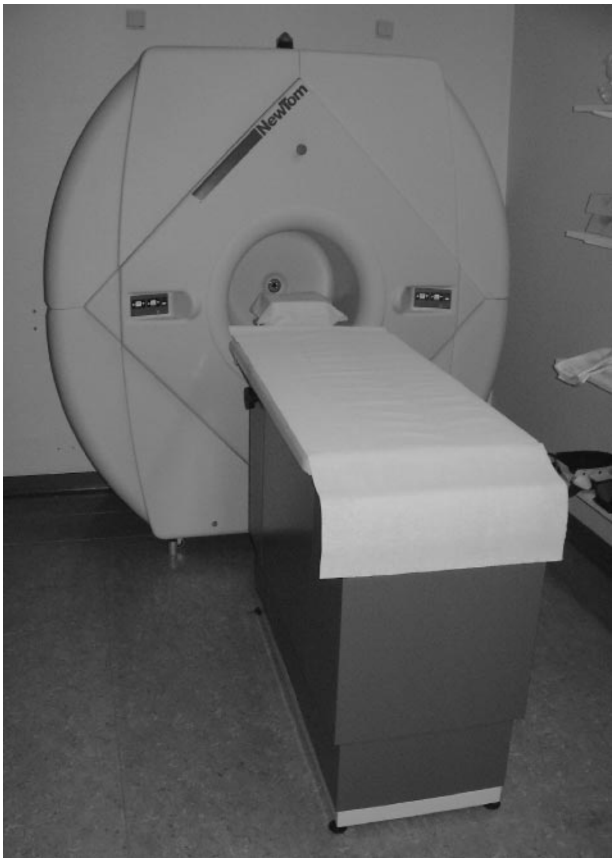


Figure 1 Photograph of the NewTom (NewTom AG, Marburg, Germany)

Figure 2 Case 1: The panoramic radiograph is poorly positioned due to the patient's multiple trauma. It shows fractures at the right mandibular angle and the left canine and premolar region

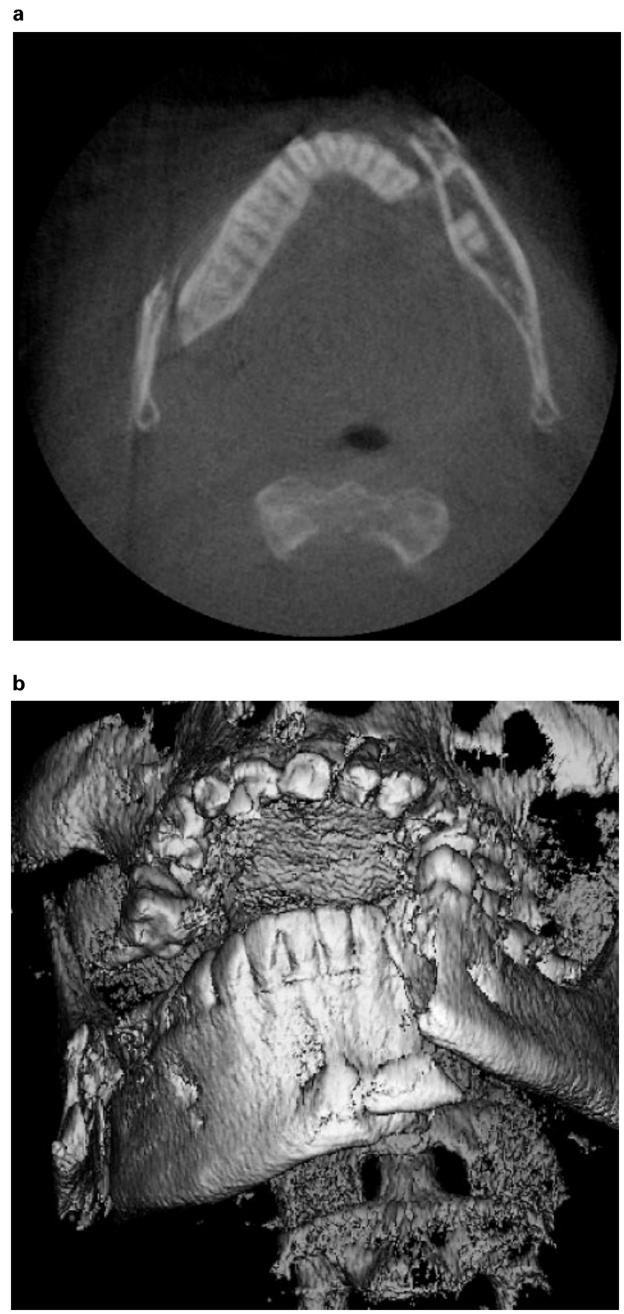


Figure 3 (**a**) Axial DVT and (**b**) 3-D reconstruction confirm the fractures at the right mandibular angle and demonstrates clearly the parasymphyseal fracture in the left canine region. The 3-D reconstruction also shows a displaced fragment at the inferior cortex

small fragment at the inferior margin of the left mandible. The temporomandibular joints could be assessed in the more superior axial cuts.

Comment The poor quality panoramic radiograph resulted from problems in positioning a polytraumatised patient in the machine. One advantage of the NewTom is that patients who cannot be placed in an upright position can, as with conventional CT, be positioned supine. As the figures show, the fractures, as well as the temporomandibular joints, can be assessed in 3D without further radiation exposure. In complex facial trauma, standard imaging is inferior to three-dimensional reconstruction.

Case 2:
A 55-year-old man presented with a squamous cell carcinoma of the left floor of the mouth. The

panoramic radiograph (Figure 4) showed an osteolytic area in the left premolar region immediately above the mental foramen. The axial DVT (Figure 5a) confirmed the extent of bone defect, while the para-axial (Figure 5b) views demonstrate the involvement of the inferior dental canal.

Comment Demonstration of the bone defect on DVT is comparable to a conventional CT, but with a lower radiation dose. Because DVT can generate a panoramic view, a separate conventional panoramic radiograph is unnecessary.

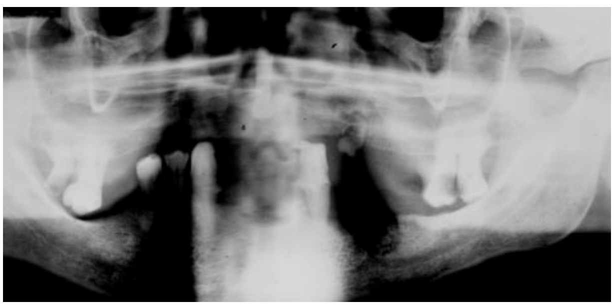


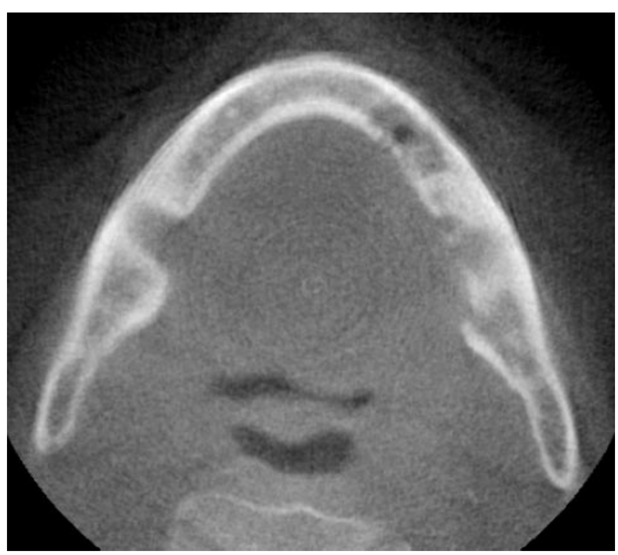
Figure 4 Case 2: Panoramic radiograph showing tumour invasion in the left premolar region

Case 3:
A 72-year-old woman had a suspected recurrence of an ameloblastoma in the right maxilla. Conventional occiptomental and panoramic radiographs were inconclusive. Coronal DVT (Figure 6) showed cystic lesions strongly suggestive of a recurrence, which was confirmed at operation.

Comment The demonstration of tumours involving the maxillary antrum is problematic on plain radiographs, so that a conventional CT is modality of choice. In comparison, DVT can provide the same information at a lower radiation dose.

Case 4:
A 65-year-old man underwent an endosseous implantation in the upper left premolar region. Postoperative coronal DVT (Figure 7) showed that the implant had penetrated the antral floor. The adjacent antral mucosa is thickened.

a



b

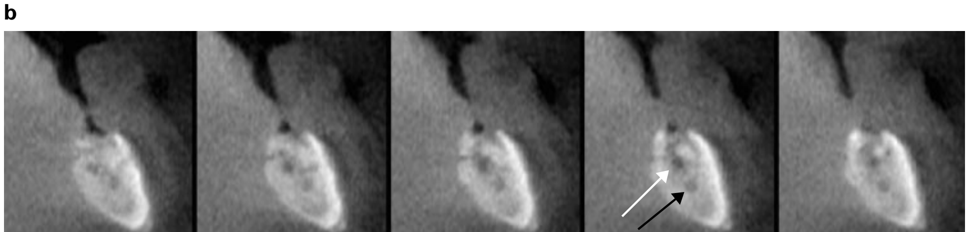


Figure 5 (**a**) Axial DVT confirms the extent of the bone defect in the left mandible. (**b**) Paraxial DVT through the same area showing invasion of the inferior dental canal (black arrow) by the tumour (white arrow)

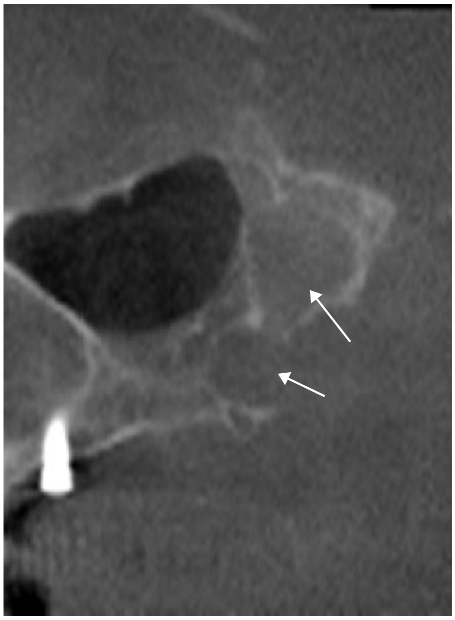


Figure 6 Case 3: Coronal DVT confirms the presence of a recurrence in the right maxilla (arrows)

Figure 7 Case 4: Post-operative coronal DVT showing that the implant has penetrated the antral floor with thickening of the adjacent antral mucosa

Comment Note the absence of metallic artefacts which could be a contraindication to conventional CT.

Discussion

The development of new operative techniques in oral and maxillofacial surgery within the last few years had led to an increasing demand for three-dimensional digital imaging.[3,5–8] The cone-beam technique (or DVT) is the most recent advance in computer-assisted tomography.[3,9] Our initial experience with phantoms confirms previous reports of a geometric accuracy of tenths of millimetres.[10] DVT offers the option of skull imaging with high geometric accuracy in all spatial planes as well as three-dimensional reconstruction at high resolution.[6] Up to now, these options have only been available with standard CT. Although it is possible with low-dose techniques to achieve a dose reduction of 76% without losing diagnostic accuracy, this is till 10 times more than the effective dose of a panoramic radiograph[2] or conventional dental imaging.[11,12] Dula et al[13] stated that a low-dose protocol for implant assessment leads to a risk reduction of 50–60%. However, these authors argued that CT is indicated only for anatomically difficult cases or with extensive implant treatment. Therefore the smart-beam technique of the NewTom provides an option for digital three-dimensional imaging of routine cases with an acceptable radiation risk.[10,14] The clinical cases shown in this paper illustrate its wide range of potential applications. It is simple to use and easily integrated into routine practice, particularly for trauma and implantology.[6] In our experience, image quality for dental implant planning is at least equivalent to either conventional tomography or CT.[15] On the other hand, it is superior in that examination time is shorter and costs lower compared with CT.[4,10] Although DVT costs more than conventional panoramic machines, neither these nor the Scanora® multimodal unit[16,17] offers the range of diagnostic options.

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