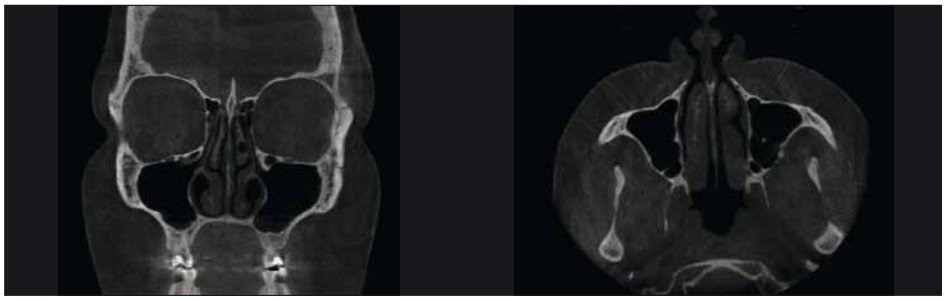
ENT diagnostic imaging using cone beam CT

Diagnostic imaging of the ear, nose and throat (ENT) area has traditionally been carried out with medical CT, MRI and standard radiography. Nowadays there is a transition towards using more cone-beam computed tomography (CBCT) for certain diagnostic tasks in these areas. The successful introduction of a CBCT system for ENT applications, in addition to applications in the dental field where the method already plays a major role, is described here.

by Dr Jorma Järnstedt, Dr Prasun Dastidar and Matti Linnosaari

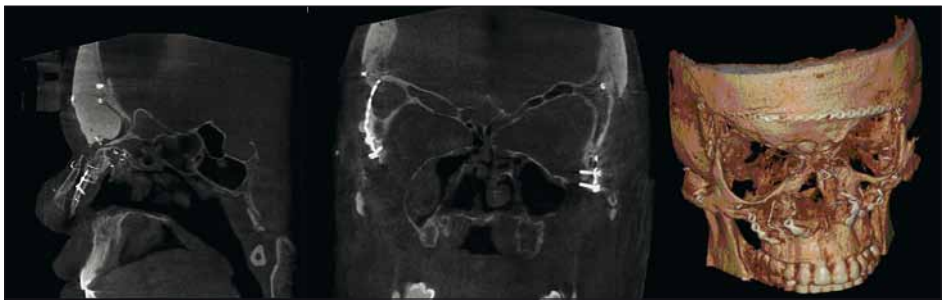
ENT imaging

CBCT enables various diseases of the ear, nose and throat to be imaged using an accurate three dimensional technique. In addition to the earlier conventional use of CBCT in dentomaxillofacial radiology, the technique is being increasingly used in the diagnosis of diseases of the sinonasal area, for maxillofacial trauma and temporal bone diseases. CBCT has now become popular with clinicians because of its ability to image structures three dimensionally and at the same time to visualise both bony and soft tissue structures with extremely thin section high resolution images. The main advantages of CBCT over standard medical CT are the comparatively low doses of ionic radiation used (3-6 times), the extremely thin sub-millimeter (0.1-0.2 mm) slices in axial, coronal and sagittal planes and subplanes, with additional automatically generated surface and volume reconstructions and the high resolution bone details of the maxilla, mandible and the temporal bones.



Case 1. Normal sinus CBCT of a 31 year old female, who had clinical symptoms of sinusitis.

Case 2. 42 year old male, with massive polyposis of the ethmoidal sinuses and left nasal cavity and an incidental finding of osteoma in the left ethmoidal sinus. In addition there is a presence of air-fluid levels in the maxillary sinuses.

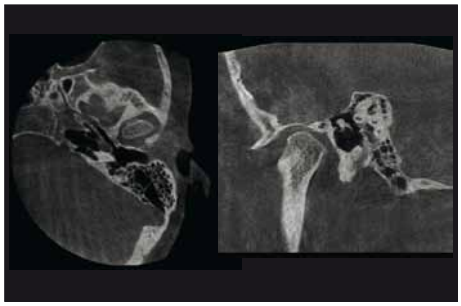


Case 3. 36 year male. Postoperative CBCT in a patient with congenital anomalies of the facial bones.

In the sinonasal region, the origin of the site of infection in sinusitis can be effectively determined with accuracy and precision using CBCT and a fairly low dose of ionic radiation. Sinusitis can be of odontogenic origin, via a soft tissue density mass within the sinuses, originating from a carious tooth with defective restoration, or an extraction site with or without a radiographically evident periapical lesion and mucosal thickening limited to the area of the tooth or extraction site in question. Sinusitis can also be of nonodontogenic origin, from a soft tissue density mass within the sinuses originating from conditions such as asthma, allergy and polyposis, and in the absence of carious tooth and mucosal thickening not limited to any tooth. Sinusitis can also be of undetermined origin- a soft tissue mass with carious tooth and mucosal thickening not limited to the affected tooth. All three types of sinusitis can be effectively imaged with CBCT. Its use in imaging diseases of the temporal bone and the inner ear has now been well established [1]. Structures that can be particularly well-visualised include the ossicular chain, the bony labyrinth of the inner ear, the anatomy of the internal cochlear and the facial nerve. Reduced metal artifacts are noted with cochlear implant imaging, as well as the improved detection of small laser-induced lesions in the ossicular chain as compared to images from multidetector CT (MDCT).

The SCANORA 3D low dose CBCT system

This compact CBCT system enables diagnostic imaging of the dentomaxillofacial and head and neck areas. Various field-of-view sizes and high/standard resolutions can be selected for different imaging tasks. The cylindrical field-of-view sizes range from 6x6 cm up to 13x14.5 cm. The voxel sizes, which represent the spatial resolution, range from 133 µm to 350 µm. Standard resolution offers fast imaging with low dose, suitable for follow-up and measurement tasks. High resolution is recommended for primary diagnostics. In addition to excellent diagnostic performance, special concern has been addressed with regard to the ALARA principle (As



Case 4. 29 year old female complaining of pain in the temporal bone area which commenced on an aeroplane. The eustachian tube was obstructed. The temporal bone area was otherwise normal.

Low As Reasonably Achievable). Dose levels of this system are considerably lower than with medical CT imaging, depending on the selected field of view (FOV). With high resolution CBCT imaging of the temporal bone, the dose is approximately equivalent to one to two panoramic images. In high resolution sinonasal imaging with a large field of view, the dose is approximately equivalent to three panoramic images. The system offers superior versatility by combining cone beam 3D imaging with a CMOS flat panel detector and dental panoramic imaging with a CCD sensor. At the press of a button, the unit automatically switches between 3D and panoramic imaging modes with the AutoSwitch function, making it quick and efficient to use.

The volume of interest can be freely located in the skull area, thanks to the motorised positioning movements of the unit. The appropriate volume can be accurately located with laser positioning lights. The system enables the workflow to be as fast and efficient as possible. Short scan and reconstruction times further increase the efficiency and usability of the unit. Reconstruction times are fast, starting from one minute. Compared to traditional image intensifiers the flat-panel detector offers superior image quality due to its large dynamic range, better contrast and lack of image distortion. Additionally it is insensitive to electromagnetic interference, compact in size and has a very long service life.The separate CCD sensor for panoramic function produces high quality 2D images. In addition, the panoramic view can also be reconstructed from the 3D data, then the focal through can be freely adjusted after exposure. The system is a total 3D imaging solution and comes with a complete 3D software package for advanced diagnostics. Through DICOM support, the system integrates with PACS and is compatible with most third party software, drill and surgical guide applications.

Clinical use

The use of a newly installed SCANORA 3D system in the diagnosis of various diseases of the ear, nose and throat is reported here. The machine is installed in a moderate-sized private radiology clinic in Tampere, Finland. In the three months since the system was installed patients with acute and chronic sinusitis, temporal bone diseases and inner ear anomalies have been studied to analyse the safe use of this new technique in various ENT diseases.

The main use of our system has been for the imaging of the paranasal sinuses ie., sinusitis and polyposis. Our ENT surgeons have been more than satisfied with the availability of images in 3D planes obtained using extremely low radiation doses. In the head and neck and temporal bone areas, the main use of the system at our institution is for the preoperative evaluation of the anomalies in the maxilla, mandible and inner ear, but the system has worked equally well in cases of infections and trauma of the temporal bone. The image data have also been used for virtual planning and navigation. Images of some of our cases [Cases 1 - 4] are presented.

Reference

1. Miracle AC and Mukherjee SK. Conebeam CT of the head and neck Part2: Clinical Applications. AJNR 2009; 30:1285-1292.

The authors

Jorma Järnstedt DDS, Specialist of dentomaxillofacial radiology, and Prasun Dastidar, MD., PhD, Medical Imaging Centre, Tampere University Hospital and Röntgentutka Corporation, Tampere, Finland.
Matti Linnosaari, Product Manager, SOREDEX
www.soredex.com

SOREDEX designs, develops, manufactures and markets X-ray imaging systems, with an emphasis on innovative digital solutions. Operating worldwide, the company offers quality imaging systems of true diagnostic value, based on an in-depth understanding of the practice. Applying three decades of experience of imaging excellence, reliable and easy-to-use solutions are offered that help clinicians focus on patient care. Based in Finland and part of the PaloDEx Group Oy, SOREDEX stands for innovation and value in X-ray technology.

i www.ihe-online.com & search 46040