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Dear colleagues, distributors and friends,

CBCT and CBCT imaging is one of the most challenging scientific topics and has attracted lots of attention in recent years. All the scientific research and development have to be turned into practice to produce benefits and efficiency in the daily lives of CBCT users. A great example of practical implementation is the fact that the application of CBCT is no longer limited to the dental area, but has been extended into medical, in particular, ENT imaging. As a result, CBCT is considered more and more to become a standard also in medical radiology.

We are proud to publish the third edition of SOREDEX® abstract booklet: this edition focuses on dentomaxillofacial and ear, nose and throat imaging giving the reader an overview how multiple the opportunities are with CBCT. The booklet includes a collection of six interesting and challenging DMFR and ENT cases dealt by Finnish and Serbian experts.

By launching this booklet, SOREDEX aims to strengthen its status as a medical provider and hopes to inspire you to discover even further applications for the maximal leverage of CBCT technology.

Yours sincerely,

Ms. Tiina Holkko, VP, General Manager, SOREDEX
Dr. Jörg Mudrak, DDS, DMD

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**SCANORA® 3Dx**
The in-office Cone Beam CT system for maxillofacial and ENT clinicians and physicians
Temporal Bone Case Study: Exostoses of the External Auditory Canal (EAC)

© Doc Dr Snezana Sankovic-Babic,
ORL Clinic KBC Zvezdara Belgrade, Serbia

A 52-year-old male patient, a professional diver, suffered from slowly developing conductive loss of hearing. The patient had no records in medical history concerning any kind of chronic diseases, neither infections nor injuries of the ear.

An ENT examination confirmed a bilateral narrowing of the external auditory canals, being more prominent at the right ear. An audiometry test showed a bilateral conductive loss of hearing, predominantly at the right ear.

A CBCT scan by SCANORA® 3Dx (SOREDEX, Finland) was performed in order to make a preoperative plan for the treatment of Exostoses of the external auditory canal (EAC). The acquired CBCT data were used to:

- define the extent of EAC stenosis (Fig. 1-3)
- assess the course of the facial nerve

- define the structure and status of middle ear bony walls and hearing bone chain (Fig. 4, 5)
• analyze the mastoid structure (Fig. 6)

**Fig. 6** Well pneumatized both mastoids in patient with Exostoses of EAC, axial projection.

**Fig. 7** Patient with exostoses of EAC, coronal section. Both attic spaces of the middle ear and mastoids are normal.

**Conclusion**

Acquiring CBCT data improves the quality of preoperative treatment planning in patients with Exostoses by visualizing the needed anatomical information.

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**Case Report: Maxillary Sinus Cyst**

© Doc Dr Snezana Sankovic-Babic, ORL Clinic KBC Zvezdara Belgrade, Serbia

A patient showed up at the clinic, suffering of chronic rhinorrhoea with cephalæa for more than six months. Despite of a conservative treatment (more than three different antibiotics and anti inflammatory drugs), a constant feeling of pressure dominated the left facial side.

The ORL examination, rhinoscopy and nasal endoscopy showed these clinical findings: confirmed slight deviation of the nasal septum and revealed signs of a chronic rhinitis.

A 3D CBCT image by SCANORA® 3Dx (SOREDEX, Finland) showed some cystic formation in the left maxillary sinus (Fig. 1-3).

**Therapy:** Patient chose Functional Endoscopic Sinus Surgery (FESS).
Use of CBCT in the Diagnosis of Cervical Spine Spondylosis
© DDS, Specialist in dentomaxillofacial radiology Jorma Järnstedt and MD, PhD, Neuroradiologist Prasun Dastidar Tampere University Hospital and Röntgentutka Corporation

Introduction
CBCT has been conventionally used to diagnose diseases of the maxillofacial area for many decades. In the past few years sinonasal imaging with CBCT has become popular due to its low radiation dosage. The field of CBCT has received a great deal of R&D attention and consequently, technological progress has been fast and innovations frequent. As a result, the next appropriate area of CBCT imaging seems to be the area of cervical spine ranging from the level of occiput till the level of C7. Due to the drastic increase of patients with cervical spondylosis and new operative techniques of spondylodesis the need for CT of the cervical spine has significantly increased. Compared to MDCT of cervical spine the radiation dose of CBCT of cervical spine is considerably lower, i.e., comparable to AP and lateral views of cervical spine X-ray, but with much more detailed information of the spinal cavity and intervertebral foramina. The extent of false-positive diagnosis of intervertebral foraminal narrowing is dependent on the positioning of the patient in oblique views of the cervical spine. With CBCT of cervical spine this can be avoided.

Indications for a CBCT of the cervical spine are as follows:
1) Cervical spine spondylosis leading to spinal stenosis
2) Facet joint arthrosis and associated dislocations
3) Inter-vertebral foraminal stenosis
4) Postoperative analysis of the anterior spondylodesis operations
5) Traumatic fractures
6) Bony tumors and associated destructions.

SCANORA® 3D CBCT system
SCANORA® 3D system is a cone beam CT imaging system that is intended for the head and neck area. The unit has been in use at Röntgentutka private clinic in Tampere, Finland, for several years mainly for maxillofacial and sinus diagnostics. Recently the system has been used also for upper cervical spine examinations and has been found extremely useful.

The fields-of-view (HxD) of the unit are 60x60 mm, 75x100 mm, 75x145 mm and 130x145 mm, and they are selectable according to the diagnostic task at hand. SCANORA® 3D provides a seated patient platform and the region of interest can be freely located in the head and neck area thanks to motorized movements and laser lights. The voxel sizes for adjusting the spatial resolution are selectable in the range of 133 - 350 µm. The protocol can be optimized for each diagnostic task to produce proper image quality at minimum radiation dose.

The cervical spine can be scanned starting at level occiput till C7. The field of view is 130-145 mm. The voxel size is 0.3 mm, and the amount of radiation dose can be lower than recommended for example of that of the head and neck area. With CBCT this area can be well demonstrated depending on the patient anatomy: in severe obesity cases the level of C7/T1 could be difficult to demonstrate without technical innovations. At SCANORA® 3D the patient is stable in anatomically optimal sitting position and the mandible is in a comfortable, optimal position resting on a plastic stand. In contrast, with MDCT scanning the patient is in a lying position, which changes the physiological position of the cervical spine.
Discussion of sample case

**Case 1:** A middle-aged male patient was presented with symptoms of radiating pain in the left cervical region radiating towards left upper limb. In addition, he had movement restrictions of the neck on the left side. He had also noticed a bony lump in the left upper neck area. He consulted his neurosurgeon who referred the patient directly to CBCT of the cervical spine. On CBCT at level C3-C4 spondylotic hypertrophy of the left facet joint was found, which led to lateral stenosis of the intervertebral foramen in addition to a bony prominence on the left side. Axial, coronal and sagittal slices in addition to surface reconstructions show the changes in details. The patient is now awaiting his surgery, i.e. facetectomy at level C3-C4 after an ENMG examination to rule out nerve degeneration.

**Case 2:** A middle-aged female patient was referred to CBCT of the cervical spine for restricted neck movements and mild radiating pain to both upper limbs. Also a history of giddiness was elucidated. Cervical spondylosis was suspected. On CBCT images, axial, coronal and sagittal slices in addition to surface reconstructions show mild arthrosis of the bilateral facet joints at upper cervical spine and posterolateral spondylosis at level C3-C6. Minimal narrowing of the bilateral intervertebral foramina may be noticed. The patient is currently undergoing medical treatment for spondylosis.
**Case 3:** A middle-aged female patient was referred to CBCT of the cervical spine for severe radiating pain of both upper limbs. A diagnosis of cervical spondylosis with inter-vertebral foraminal narrowing was suspected. On CBCT axial, coronal and sagittal images showed severe bilateral intervertebral stenosis at level C4-C5. The patient is awaiting an ENMG examination after which she will undergo a surgery.

**Conclusions**

At our clinic we have found the oblique views of plain radiographs not to be optimal enough to demonstrate the condition of intervertebral foramina. These radiographs are neither selective nor sensitive. In all cases of radicular pain of the upper limbs we recommend the simultaneous use of CBCT and MRI for presurgical evaluation.

CBCT with its low radiation dose is suitable for demonstration of cervical spondylosis and associated complications. Ventrolateral and posterolateral spondylosis leading to spinal and lateral stenosis may be well demonstrated during presurgical evaluation. Also rheumatic conditions of the upper cervical spine including atlantoaxial dislocation are well indicated by CBCT. Moreover, hair line fractures of the cervical spine and bony lytic tumors are well demonstrated by using CBCT. As a conclusion, we suggest that CBCT of the cervical spine should be routinely indicated for patients referred to surgical intervention.

**References**

Using CBCT in Diagnosis and Evaluation of Le Fort Fractures
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Introduction
Le Fort fractures are types of fractures that involve the maxillary bone and surrounding structures. René Le Fort published his landmark work, a three-part experimental study, of the examination of break patterns of crush injuries of 32 cadavers that were either intact or decapitated.\(^1\)\(^-\)\(^3\)

The heads of the cadavers were subjected to various types of trauma; the soft tissue was first removed and the bones were examined. Le Fort noted that, generally, if the face was fractured, the skull was not. He then stated that fractures occurred through three weak lines in the facial bony structure: those that protect the cranial cavity, those that circumscribe the midface, and those that cut across the face. From these three lines the Le Fort classification system was developed.

Figures 1, 2 and 3 demonstrate antero-posterior and lateral views of the skull showing the Le Fort classification system of maxillary fractures.\(^4\)

Le Fort I Level (horizontal): May result from a force of injury directed low on the maxillary alveolar rim in a downward direction. It is also known as a Guérin fracture or ‘floating palate’, and usually involves the inferior nasal aperture. The fracture extends from the nasal septum to the lateral pyriform rims, travels horizontally above the teeth apices, crosses below the zygomaticomaxillary junction and traverses the pterygomaxillary junction to interrupt the pterygoid plates. (Fig. 1)

Signs and Symptoms
Le Fort I - Slight swelling of the upper lip, ecchymosis is present in the buccal sulcus beneath each zygomatic arch, malocclusion, mobility of teeth. Impacted type of fractures may be almost immobile and it is only by grasping the maxillary teeth and applying a little firm pressure that a characteristic grate may be felt, which is diagnostic of the fracture. Percussion of upper teeth results in cracked pot sound. Guérin’s sign is present characterized by ecchymosis in the region of greater palatine vessels.

Le Fort II Level (pyramidal): May result from a blow to the lower or mid maxilla and usually involves the inferior orbital rim. Such a fracture has a pyramidal shape and extends from the nasal bridge at or below the nasofrontal suture through the frontal processes of the maxilla, inferolaterally through the lacrimal bones and inferior orbital floor and rim through or near the inferior orbital foramen, and inferiorly through the anterior wall of the maxillary sinus. It then travels under the zygoma, across the pterygomaxillary fissure and through the pterygoid plates. (Fig. 2)

Le Fort II - Step deformity at infraorbital margin, mobile mid face, anesthesia or paresthesia of cheek.

Le Fort II and Le Fort III (common) - Gross edema of soft tissue over the middle third of the face, bilateral circumorbital ecchymosis, bilateral subconjunctival hemorrhage, epistaxis, CSF rhinorrhea, dish face deformity, diplopia, enophthalmos, cracked pot sound.

Le Fort II - Step deformity at infraorbital margin, mobile mid face, anesthesia or paresthesia of cheek.
Le Fort III Level (transverse): Is otherwise known as craniofacial dissociation and involves the zygomatic arch. This may be caused by impact to the nasal bridge or upper maxilla. These fractures start at the nasofrontal and frontomaxillary sutures and extend posteriorly along the medial wall of the orbit through the nasolacrimal groove and ethmoid bones. The thicker sphenoid bone posteriorly usually prevents continuation of the fracture into the optic canal. Instead, the fracture continues along the floor of the orbit along the inferior orbital fissure and continues superolaterally through the lateral orbital wall, through the zygomaticofrontal junction and the zygomatic arch. Intranasally, a branch of the fracture extends through the base of the perpendicular plate of the ethmoid, through the vomer, and through the interface of the pterygoid plates to the base of the sphenoid. This type of fracture predisposes the patient to CSF rhinorrhea more commonly than the other types of fractures.5 (Fig. 3)

Signs and Symptoms
Le Fort III - Tenderness and separation at frontozygomatic suture, lengthening of face, depression of ocular levels, enophthalmos, hooding of eyes, tilting of occlusal plane with gagging on one side.

Case report
A 40-year-old, healthy patient showed up in the clinic, suffering from a severe accident. The clinical examination showed a dish face deformity, edema of soft tissue covering the middle third of the face, bilateral circumorbital ecchymosis, bilateral subconjunctival hemorrhage, epistaxis, diplopia, enophthalmos and cracked pot sound.
A native radiography was obtained and a Le fort I, II, and III as well as a fracture of the nasal bone could be diagnosed.

Due to the degree of the trauma the patient was scheduled for immediate surgery. The surgical protocol included manual repositioning of the fractured segments of the maxilla by performing Le Fort I, II, II surgery and the osteosynthesis by metal plates no 4. Immediately after surgery, a CBCT scan was acquired (SCANORA® 3Dx, SOREDEX, Tuusula, Finland), to evaluate the surgical outcome.

The axial view shows the repositioned fragments of the lateral orbital wall (Fig. 4 A and B), a fracture of the maxillary process and the distal wall of the maxillary sinus (Fig. 5 C, D, E and F), and a fracture of the lateral pyriform rims (Fig. 6 G).
Fig. 5  C, D, E and F  Axial view of the fractured maxillary process and distal wall of the maxillary sinus.

Fig. 6 G  Axial view of the fractured lateral pyriform rims.

The coronal view shows the fractured frontal and maxillary sinus walls (Fig. 7 H), the zygomatic bone fracture, an orbital blowout fracture and an alveolar process fracture (Fig. 8  I and J).

Fig. 7 H  Coronal view of the fractured frontal and maxillary sinus walls.

Fig. 8 I and J  Coronal view of the zygomatic bone fracture, the orbital blowout fracture and the alveolar process fracture.
Discussion

Cone Beam computed tomography (CBCT) is the modality of choice for the evaluation of facial traumas, helping to identify and characterize fractures and associated complications in detail, as well as for evaluating the surgical outcome. CBCT imaging is an important technique in supporting timely clinical management and surgical planning.6

References


Silent Sinus Syndrome

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Patient: A 45-year-old otherwise healthy airline pilot, with a history of maxillary sinusitis followed by nasal stuffiness and pressure equalization problems in right maxillary sinus in 7-10/2010.

During this time period the patient experiences some minor visual accommodation problems. They disappeared with active treatment antral saline lavages and antibiotics.

The patient stays symptomless for almost 1,5 years, with no problems related to pressure changes.

The patient experiences right maxillary pain during flight without respiratory infection again in 2/2012. Visual accommodation problem returns, with numbness in cheek and right upper teeth. Pain increases in landing. Again treatment with antibiotics. Antral lavage gives thick mucous secretion, with positive culture for E.Coli and good response to doxycline antibiotic treatment. The patient returns to flying after control lavage in one week. No more pain or further pressure induced problems at this point.

After two weeks the patient notices double vision when looking up right or down left. This worsens during pressure changes, especially when landing. He is grounded from flying. Pressure is felt in right eye when blowing nose. When pressing the right eye, patient feels pain in right upper teeth. The wife of the patient notices that right eye seems to be lower than left, with slight enoftalmus.

In a 3D CBCT scan with SCANORA® 3Dx (SOREDEX, Finland) right maxillary sinus is homogenously opacified and the ostiomeatal area is lateralized. The uncinate process is located tightly against the lamina papyracea and the roof of maxillary sinus/orbital floor is lower than normal. No visible bone between orbita and maxillary sinus and at the posterolateral wall of maxillary sinus can be seen. Minor mucosal swelling in left maxillary and ethmoidal sinus walls and maxillary sinus ostium area are seen. Other sinuses appear to be normal. (Fig. 1, 2, 3 and 4).
The patient is successfully operated endoscopically (FESS). During operation the right maxillary sinus is found to be full of thick tenacious mucus and the bone of the orbital floor and medial as well as posterolateral wall is thinned and partly absent.

The patient returns to flying two weeks post-operatively after complete resolution of symptoms. Also the cosmetic difference between orbitae disappears.

Silent sinus syndrome is a complex problem with changed operative anatomy. SCANORA® 3Dx CBCT system is a perfect tool when accurate 3D spatial visualization is needed when planning endoscopic sinus surgery in complex cases.

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**CBCT Predicted Marginal Mandibular Resection of a Patient with Oral Squamous Cell Carcinoma**

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One of the most important aspects of preoperative staging in head and neck surgery is the presurgical determination of malignancies’ local bone invasion, because prediction of the extent of the surgical procedure is very important for the surgical outcome. It is especially important if a tumor extends into bone structures, i.e., the mandible, because it requires often a mandibulectomy. In addition, for such cases, the superoinferior extent of bone invasion is important for the surgeon to plan for either marginal or segmental mandibulectomy. According to the modern literature, the standard protocol for staging oral cavity malignancies includes MSCT and MRI imaging of head and neck, CT, conventional 2-plane X-ray of the chest and abdominal ultrasound. The results gathered from MSCT, MRI and CT are usually reviewed to determine if local bone invasion has occurred. In 1998 cone-beam computerized tomography (CBCT) technology was clinically introduced, allowing 3-dimensional (3D) diagnosis of hard tissues of the face and jaws, third molars, salivary calculi and other indications.

There is also evidence that CBCT is a potential tool in the assessment of facial skull bone invasion caused by oral cavity malignancies. Based on newest literature data, which relates to the comparison of the sensitivity and specificity, it can be concluded that CBCT is superior to CT and MRI in the assessment of tumors’ bone invasion in the maxillofacial region. Further advantages of CBCT imaging include lower radiation doses than MSCT and its ability concerning the anatomic assessment of the stomatognathic system.

This case report presents a 55-year-old male patient suffering from oral squamous cell carcinoma (OSCC) (Figure 1).
In order to obtain more precise information and to predict an appropriate surgical planning related to the extent of bone invasion, a CBCT of the mandible was performed (SCANORA® 3Dx, Tuusula, Finland).

In this section (axial view, Figure 3) it may be seen that the tumor invades the lingual mandibular cortex in the symphyseal region, extending up to the buccal cortex.

The image editing software (OnDemand3D™, Cybermed, Korea) offers a tool for the quantification of measurements by using the ROI and Profile function.

ROI analysis of the bilateral segments of the mandible showed a lower average grey scale value in the suspected osteolytic zone (Figure 4, 5).
Following a detailed examination of the suspect mandibular bone invasion, the precise surgical plan could be made. Resection lines were determined according to the Profile and ROI tools results (Figure 6).

In this case, a marginal mandibular resection was the treatment of choice, performed "en block" with specimen of radical neck dissection taken (Fig. 7, 8).

According to the adequate preoperative, CBCT based, surgical planning, the tumor could be resected in toto, showing free margins in the non-resected area of the mandible.

Due to its variability in imaging and resolution, CBCT could be of great importance in oncologic surgery and diagnoses.
References:


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