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SOREDEX®
Medical Case Report Booklet
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Editorial

Dear colleagues, distributors and friends,

SOREDEX is proud to publish already the 5th edition in its series of case report booklets initiated in 2013. These booklets aim to share information concerning CBCT imaging and its, yet widely undiscovered, opportunities for various clinical indications. Additionally, our goal is to inspire and encourage clinicians to study, use and endorse CBCT technology for the benefit of rapidly progressing research and development within the area.

This booklet includes five case studies describing clinical indications in the dentomaxillofacial and ENT regions. The cases illustrate how CBCT can be leveraged for the diagnosis of cervical spine and bone related pathologies, and show how CBCT images have turned out to serve as an accurate and radiation safe tool for producing STL models.

By the means of this booklet the ambition of SOREDEX is to reinforce its position as a medical provider and to validate its credo “The Right Tool for the Job”. And it makes us happy if you enjoy reading this booklet. We share, because we care.

Yours sincerely,

Mrs. Tiina Holkko, Vice President, Global Imaging Sales
Dr. Jörg Mudrak, DDS, DMD
The Paget’s disease
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Introduction
Paget’s disease (PDB) was first described in 1877 by Sir James Paget (1814-1899), who
was an English surgeon and pathologist, under the term "osteitis deformans".¹

Paget’s disease of bone is a focal, chronic skeletal disorder characterized by
enhanced resorption of bone as a result of an over activity of osteoclasts followed by
the formation of bone by osteoblasts. This process results in a disorganized, mosaic
pattern of woven and lamellar bone that is associated with increased vascularity,
marrow fibrosis and mechanical weakness. The affected bones can become enlarged,
less able to resist stress and deformed. The axial skeleton is primarily affected and
typically includes the pelvis (72%), lumbar spine (58%), femur (55%), thoracic spine
(45%), skull (42%) and tibia (35%), whereas the feet, hands and facial bones are rarely
affected.²

The characteristic of the initial phase of PDB, is an excessive bone resorption, followed
by increased deposition - both incidences may occur simultaneously, resulting in
osteoporosis and sclerotic bone. This sclerotic bone shows a reduced vascularity
(localized vascularity) and the possibility for normal healing is compromised, hence
it can lead to osteonecrosis.³ Therapeutic agents for PDB include bisphosphonates
like alendronate, risdonate and zoledronic acid.⁴

PDB of the bone is diagnosed primarily by a radiographic examination. Early in the
course of the disease, lytic activities predominate, causing focal osteolytic lesions.
Subsequently, areas of sclerosis develop, featuring the characteristic PDB appearance
of mixed lytic and sclerotic areas, thickened trabeculae, bone expansion, cortical
thickening and deformity.⁵

Case report
A 22-year-old female who suffered from Paget’s disease was referred to the
department by her physician for the surgical removal of impacted teeth in the
mandible and maxilla (Fig. 1).

Fig. 1 Panoramic radiograph.

The medical history revealed that the patient had been suffering from Paget’s
disease for the last three years. The extraoral examination showed enlarged cranium,
zygoma, maxilla, mandible and incomplete development of the lips, quite according
to the disease description. The intraoral examination showed additionally a diastema
and an open bite. The patient had difficulties in ingestion, swallowing and speaking.

To evaluate the referral’s diagnoses and the bone quality, a cone beam computed
scan with a 240x165 mm FOV was obtained (SCANORA® 3Dx, SOREDEX).

The analyses of the acquired data (OnDemand3D™, Cybermed) showed mixed
radiolucent and radiopaque areas, generalized teeth displacements and multiple
impacted teeth in both jaws (Fig. 2, 3, 4).

Fig. 2,3,4 Coronal, sagittal and axial views: PDB characteristics, impacted teeth.
The maxillary sinuses revealed mixed, hyper and hypo radiolucent areas, the frontal sinus was ossified (Fig. 5, arrows).

**Fig. 5** Coronal view, ossified sinus frontalis, sinus maxillares.

The rendered reconstruction of the skull showed hypertrophic and fused facial bones as permeative pattern (Fig. 6).

**Fig. 6** VR view, permeative pattern.

Due to the medical history and the lacking pathologic symptoms of the impacted teeth, a surgical intervention was rejected, and regular follow-up appointments recommended instead.

**Conclusion**

CBCT imaging can replace traditional radiological 2D imaging, like panoramic radiographs and lateral skull radiographs, when bone related malignancies are evaluated.

The opportunity to edit the images in relation to the characteristics of a certain disease, e.g. Paget’s disease, can improve the diagnoses and the visualization of these characteristics.

**References**


**Editor’s comment:**

Bisphosphonates (also called diphosphonates) are a class of drugs that prevent the loss of bone mass, used to treat osteoporosis and similar diseases. They are the most commonly prescribed drugs used to treat osteoporosis.

Most physicians use bisphosphonates to treat osteoporosis, osteitis deformans (Paget's disease of the bone), bone metastasis, multiple myeloma and other conditions involving fragile, breakable bone.

Alendronate: bisphosphate, inhibits osteoclast-mediated bone-resorption.

Risedronate: bisphosphate used to strengthen bone, treat or prevent osteoporosis, and treat Paget's disease of bone.

Zoledronic Acid: slows down bone resorption, allowing the bone-forming cells time to rebuild normal bone and allowing bone remodeling.

Source: http://en.wikipedia.org/wiki/
Use of CBCT in the diagnosis of cervical spine spondylosis

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Introduction

Cervical spondylosis is a general term for age-related wear and tear affecting the spinal disks in the neck. As the disks dehydrate and shrink, bone spurs and other signs of osteoarthritis develop.

Cervical spondylosis is very common and worsens with age. There also appears to be a genetic component involved, because some families will have more of these changes over time, while other families will develop less. More than 90 percent of people older than age 65 have evidence of cervical spondylosis and osteoarthritis that can be seen on neck X-rays. Most of these people experience no symptoms of these findings. When symptoms do occur, nonsurgical treatments are often effective.

SCANORA® 3D CBCT system

The SCANORA® 3D system is a cone beam CT imaging system that is intended for head and neck area. The unit has been in Röntgentutka imaging center 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 it has been found very useful there.

The fields-of-view (HxD) of the unit are 60x60 mm, 75x100 mm, 75x145 mm and 130x145 mm and selectable according to the diagnostic task at hand. In this seated patient platform 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 a minimum dose level.

Discussion of sample patient cases

Patient 1: A middle-aged male patient was referred to us with a complaint of local pain in the left upper cervical region. The neurosurgeon found a bony tumor in the region of C3, and a CBCT image of the cervical spine was taken immediately without going for a normal X-ray of that region. The CBCT showed a severe arthrosis of the facet joint, where one can see a bony mass formed by bone degeneration in that area both in the medial and lateral borders of the facet joint. It also shows relative lateral stenosis. Furthermore, images show the mass in the axial, coronal and sagittal planes and in 3D surface reconstruction picture. The patient was referred to a resection of the lesion and foraminotomy.
Patient 2: A young female patient complained of pain and tenderness of the neck and restricted movements of the cervical spine to a neurologist, who sent the patient directly to a CBCT of the cervical spine. A sagittal image showed that there were both anterior and posterolateral cervical spondylosis and loss of lordosis in that area. In addition, the spondylotic changes narrowed the main spinal canal in these areas. A coronal image also showed the mild arthrosis of the facet joints bilaterally. Axial images did not show any stenosis of the spinal canal or the intervertebral foramens. A 3D surface reconstruction showed the above mentioned changes.

Patient 3: A middle-aged male patient complained of severely restricted movements of the cervical spine and in addition to that, bilateral radiating pain in both upper extremities. Axial reformations showed a severe stenosis of the intervertebral foramens at C4-C5 level. Both postero-lateral spondylotic changes and facet joint arthrosis led to the shown stenosis. The patient was referred to an orthopedic specialist for further treatment. A 3D surface reconstruction picture showed the above-mentioned changes.
Conclusion

CBCT of the cervical spine is an excellent examination for diagnosis of cervical spondylosis, facet joint arthrosis and stenosis of the intervertebral foramina with minimum radiation to the patient. With CBCT one can image all cervical spine vertebrae till the C6-C7 area in all kinds of patients, varying from obese to lean patients with a swan-neck. In our institution we have recommended the surgeons not to go for a native X-ray image with AP, lateral and oblique projections due to the radiation involved and to the poor diagnosis in these cases. Patients with radiating pain in upper extremities are often referred for a MRI of the cervical spine, where the diagnosis of a prolapse/protrusion can be well made, but not of the bony stenosis/spondylosis or facet-joint arthrosis. The degree of stenosis in the spinal canal and the intervertebral foramina can be analyzed clearly by the means of CBCT. As a conclusion, CBCT of the cervical spine is recommended for these patients instead of native X-rays.

Effects of cone beam imaging on a spondylodesis procedure

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Introduction

Diagnostic imaging of the cervical spine has been normally done with medical CT (MDCT) and 2D native X-ray units. While medical CT produces high diagnostic yield, the drawback is relatively high X-ray dose. 2D skull imaging apparatus produces only one projection at a time, i.e. many exposures are needed to fulfill the diagnostic task. The recently introduced Cone Beam CT (CBCT) imaging technique can offer an alternative worth of considering for cervical spine imaging.

The described case study clearly shows the benefits of CBCT imaging in the cervical spine area. With SCANORA® 3D by SOREDEX the field-of-view (FOV) size can be optimally selected and freely located to the region of interest in the cervical spine area. The unit is designed so that the whole cervical spine from C1 to C7 can be imaged in one exposure program, the patient being in comfortable seated position on the integrated chair. The technical factors of the protocol were 90 kV, 13 mA, 6.6 s. The voxel size was 250 µm and the Dose Area Product 1000 mGy·cm².

The bony structures of the cervical spine appear clearly in the images. Also metallic parts show up clearly without producing too much artifacts. The CBCT imaging is very appropriate for imaging cervical spine area, because the bony structures are surrounded by soft tissues that do not harm 3D reconstruction. If the region of interest is surrounded by hard tissues, as is the case e.g. in temporal bone area, the reconstruction is more challenging.

Compared to MDCT, the CBCT method is a more cost-effective solution. Examinations are quick and more convenient for the patient in normal seated position. In vertebral imaging the patient’s head can be easily stabilized in different neck angulations for comparative studies.
**Discussion of a sample patient case**

A middle-aged female patient complained severe radiating pain in both the upper extremities and severely reduced movements of the cervical spine. After undergoing a cervical spine MRI a diagnosis of severe cervical spine spondylosis involving C3-C7 area of cervical spine was made. Because the lesions were seen in a large area C3-C7, the neurosurgeon decided to operate the patient. He decided to make an anterior spondylodesis and decompression, because lesion of the discs was also seen. Spondylodesis of the intervertebral disc spaces C3-C4, C4-C5 and C5-C6 was performed using Cornerstone (Medtronic) polyetheretherketone (PEEK) intervertebral space cages filled with autologous bone. The cages have both anteriorly and posteriorly placed radiopaque tantalum wires as metallic markers. In addition, the anterior part of the cervical spine was stabilized using a titanium alloy Venture (Medtronic) cervical plate fixed to the C3, C4, C5 and C6 vertebral bodies using titanium alloy screws symmetrically. Postoperatively we decided to judge the fixation of these implants using CBCT instead of MDCT of the cervical spine, because according to our experience the MDCT of this area is full of metallic artifacts. Axial, coronal and sagittal reformations of the operated cervical spine were made. Also the changes seen in the intervertebral areas were well defined. In addition, we made sagittal, coronal and axial 3D surface reconstructions showing the implants absolutely free of metallic artifacts. The residual spondylotic bone changes and the stenotic changes were well determined. There were minimal metallic artifacts to be seen. The metallic plate and screws were extremely well defined including the vertebral bodies, facet joints and the intervertebral foramina. Also the anterior and posterior metallic markers were well defined on CBCT. A MDCT of the cervical spine was not done, because a very good postoperative image of the cervical spine was defined.

The radiation dose of cervical spine imaging was calculated by a hospital physicist. In high resolution CBCT the efficient dose is approximately 260 µSv, with lower resolution 76 µSv. The dose is considerably lower than in MDCT. In 16 slices MDCT the calculated dose is approximately 1400 µSv, while in 64 slices MDCT with ASiR (Adaptive Statistical Iterative Reconstruction) it is 800 µSv. That is why we conclude that the average radiation dose of the patients imaged with CBCT is nearly one-third or even lower depending on the indication involved and the size of the patient.
CBCT imaging based diagnosis and treatment planning of a gigantocellulare granuloma
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Introduction
Gigantocellulare granuloma (GCG) is a benign pathological bone condition typically appearing in the anterior of the maxilla and the mandible of young people aged 20 or under, and characterized by large lesions that expand the cortical plate, absorb roots and move teeth. Histologically, GCGs are composed of multinucleated giant cells.

Radiographically, GCG appears as multilocular radiolucency of the bone. The radiological standard in diagnoses of bone related pathologies is the standard 2D panoramic image, at times supported by conventional CT.

There are two types of GCGs, non-aggressive and aggressive. The former has a slow rate of growth, and is thus less likely to absorb roots and perforate the cortical plate. By contrast, the aggressive type has rapid growth and is therefore much more likely to absorb roots and perforate the cortical plate. It also has a high rate for recurrence and can be painful and cause paresthesia.

Different diagnosis includes: odontogenic keratocyst, ameloblastoma, odontogenic tumors, fibrous dysplasia, chondrom and chondrosarcoma, among others.

Curettage is the normal treatment for GCG. Recurrence occurs in 15%-20% of cases. In aggressive tumors, three alternatives to surgery are under investigation: corticosteroids, calcitonin (salmon calcitonin) and interferon alpha-2a. These therapeutic approaches provide positive possible alternatives for large lesions. The long-term prognosis of gigantocellulare granulomas is good, and metastases do not develop.¹

Case report
A 13-year-old female patient was referred to the clinic. She had noticed a painless swelling on right side of the mandible over the past two months. The patient underwent a dental examination, including a vitality test of the teeth in the right mandible with a positive result.


Conclusion
We recommend that patients with metallic implants of the cervical spine can be imaged only with CBCT, because the quality of the postoperative images is optimal and the amount of radiation is one third of that used in MDCT of the cervical spine.
The clinical examination confirmed a painless tumefaction of the right side of the jaw, without any changes on the gums. There were no signs of trauma, bleeding or presence of liquid. The radiological 2D examination showed multilobar changes inside the body of the mandible. The involvement of teeth and soft tissue could not clearly be verified and remained questionable (Fig. 1).

To acquire more detailed information concerning the pathology, a CBCT (CRANEX® 3D, SOREDEX) was acquired, due to the need for a lower radiation dose and propagation of the lesion. The analyses of the CBCT images (OnDemand 3D™, Cybermed) clearly showed a multilobar lesion without extensive bone destruction, but with an expansion of bone; an involvement of the soft tissue could not be confirmed (Fig. 2).

In preparation of the surgery, the CBCT data was converted to stereolithography (STL) format, exported, edited and prepared for rapid prototyping. As a result, a 1:1 model of the region of interest could be printed. This technique allows the surgeon to tailor an individual treatment plan (Fig. 3).

Therapy

On the basis of the acquired information, the surgical therapy was to enucleate the tumor and to perform a histological examination of the specimen. The primary reconstruction of the defect was performed by bone augmentation (Xenograft, OSTEOVIT). The early post-operative healing period passed without any complications, and the patient was released from hospital after three days. The radiological follow-up examination, performed after three months, showed a satisfying result, supported also by the clinical follow-up examination (Fig. 4,5).
Usefulness of CBCT for producing a stereolithographic model for frontal bone defect surgery
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Introduction

The usual planning for reconstructive surgery of defects is implied by clinical and pathological examinations and 2D and 3D radiographic planning. 3D radiography is mainly acquired by the means of computed tomography (CT).

In the past few years, the surgical preoperative planning, especially of larger defects, has been performed much more precisely by using stereolithographic (STL) models based on the CT data of the patient. These models show the accurate status of defects and pathology requiring diagnostic steps.

Based on these models, the planning and production of the reconstruction materials may also be performed. Additionally, the models are helpful in the education of patients and clinicians as it is easy to demonstrate the surgical procedure and its estimated outcome with them.

The use of Cone Beam Computed Tomography (CBCT) in producing data for STL models is currently not very common. There is little experience of using CBCT technology for this procedure, yet some results may be seen in the dental field, mainly within implantological and prosthetic protocols.

STL models, based on CBCT data, can be useful and appropriate for smaller defects if adequate software and technology for the procedure have been chosen.

Conclusion

GCG is a commonly known dento-alveolar pathology, treated by means of ablative surgery. In most of the cases, the patients are cured and hardly show any recidivism of the tumor.

The basis for all successful surgery is an adequate radiological examination. In the described case CBCT played an important role by visualizing intrabony pathology thoroughly and therefore contributing to the performance of adequate surgery and optimized therapeutic outcome.

Fig. 4,5 CBCT follow-up, 3 and 6 months post-operatively.
A case report

A 49-year-old female patient showed up at the clinic. Her medical history indicated a surgical treatment of an osteoma in the frontal bone and sinus at an ENT clinic one year earlier.

The performed clinical examination showed an impression defect in the frontal bone region, approximately 5 cm of diameter, revealing pulsations of adjacent brain structures. The available CT could not deliver the needed information, because the visualization of this finding was inappropriate.

Closer analysis of the CT gave a hint of an assumed discontinuity of the frontal bone in the coronal projection, indicating further radiologic diagnoses. The acquired CBCT image (CRANEX® 3D, SOREDEX) of the specified area of the frontal bone delivered very detailed information of the region of interest (ROI) and the described defect (Fig. 1-3).

The DICOM images were edited in OnDemand3D™ software (Cybermed), transformed to STL files and then imported into Simpleware ScanIP SW (Exeter) for more detailed segmentation and individual adjustments as preparation for the 3D printing procedure by medical and technical specialists. The 3D printed model was then analyzed (Fig. 4).

Based on these analyses the surgical procedure could be planned. The surgery was performed by accessing the operating field through the existing scar, preserving the eyebrow. For covering the bony defect, a model adapted titanium mesh was used (Fig. 5).
A follow-up examination was conducted approximately 7 days postoperatively, both sides of the frontal bone were on an identical level and the surgical outcome could be considered very good (Fig. 6).

**Fig. 6** Postoperative image of the patient.

**Conclusion**

A CBCT scan may be a perfect basis for producing STL models, which enable the performance of excellent surgical planning in favor of the patient’s health. Low radiation dose and good image quality result in a fast, cheap and helpful designing of a STL model in comparison to conventional MSCT imaging.