

Radiation protection in Austria

Authors: G. Widmann, Secretary of the Austrian Röntgen Society (ÖRG); **Contact:** gerlig.widmann@i-med.ac.at
M. Uffmann, President of the Austrian Society for Radiation Protection in Medicine (VMSÖ);
Contact: martin.uffmann@neunkirchen.lknoe.at

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Founded in 1975, the Austrian Society for Radiation Protection in Medicine (VMSÖ) aims to develop basic principles and guidelines for responsible use and handling of ionising radiation in imaging and therapy.

In close scientific and organisational cooperation with the Austrian Röntgen Society (ÖRG), the society focuses on interdisciplinary research and science, advanced professional training, information and guidelines.

Advanced professional training: knowledge transfer for specialists

State-of-the-art knowledge and permanent extension studies are the society's prior conditions for quality assurance. Approbated by the Austrian Ministry of Health (BmfG), the "Strahlenschutzkurse" tend to increase protection for both patients and medical staff.

Orientation: Guidelines for protection of unborn children

By establishing general guidelines for the handling of pregnant patients, **Dr. Azadeh Hojreh** achieved great success in medical radiation safety in gynaecology and obstetrics, as well as in paediatric medicine.

Pregnancy and radiology - This presents attending doctors with a permanent need for risk-benefit analysis. The main challenge is deciding between care for the mothers and protection of the unborn child. Under the direction of Dr. Hojreh, at Vienna General Hospital (AKH), a team of radiologists, assigning hospitals, health physicists and members of the Society for Radiation Protection in Medicine was built to facilitate therapy and care for pregnant patients. The aim was to create a detailed and clear guideline considering the medical, juristic and socio-economic aspects. The result was presented on October 26, 2013 at the society's annual convention in Salzburg, where the interdisciplinary professionals were invited to help establish this guideline in Austria.

The guideline defines the course of action upon arrival of a pregnant patient and gives an overview of the kind of examinations recommended for maternal medical indications. This list is not complete and only a recommendation that is to be evaluated annually. The complete document is available at <http://radiodiagnostik.meduniwien.ac.at/allgemeine-informationen/leitlinien>

Research: Investment in a safe future

With its two awards (the Young Investigator Award as well as the Dr. Franz Holeczke Award), the VMSÖ encourages young scientists and accomplished researchers to make a contribution to the continuous advancement of radiation protection and to explore the possibilities of dose reduction. Last year's laureates were Doz. Dr. Gerlig Widmann (Dr. Franz Holeczke-Award) and Dr.med. univ. Sarah Pötter-Lang (YIA).

The scientific work of the laureates is presented below for demonstrating the ongoing efforts in radiation protection in Austria.

Substantial dose reductions for computer-assisted surgery

Widmann et al. evaluated the effect of dose reduction on the target registration error for computer-assisted surgery and the value of iterative reconstruction techniques on the subjective image quality of 2D and 3D low-dose computed tomography (CT) images of the craniofacial region and skull base.

Challenges

High-resolution isotropic CT images are commonly required for treatment planning and image guided surgery for the paediatric and mainly young and middle-aged group of patients suffering from craniomaxillofacial deformities, middle and inner ear malformations, premature synostosis, chronic sinusitis and recreational sports-related mid-face fractures. One has to take into account that most patients have already had an initial CT scan, and may require repeated CT scans for guided surgery and postoperative evaluation.

1. Use of high-resolution low-dose protocols for computer-assisted surgery.

Using Sensation Open (40-slice, intraoperative scanner), LightSpeed VCT (64-slice) and Definition Flash (128-slice) identical baseline protocols at 120 kV/100 mAs were compared to the following low-dose protocols in care dose/ dose modulation: 100 kV/35 ref.mAs, 80 kV/40 - 41 ref.mAs, and 80 kV/15 - 17 ref.mAs. A total of 33 registrations and 297 TRE (target registration error) measurements were performed in an anthropomorphic skull phantom. In all MSCT scanners, the TREs did not significantly differ between the low-dose and the baseline protocols. The difference between the sinusitis reference CTDIvol of 9 mGy and the lowest CTDIvol was approximately three-fold for Sensation Open, and 12-fold for the LightSpeed VCT and Definition Flash. [Widmann et al. Fortschr. Röntgenstr. 2012]

2. Use of adaptive statistical iterative reconstruction (ASIR) and model-based iterative reconstruction (MBIR) to enhance image quality of ultra-low dose protocols.

In a subsequent study, the subjective image quality of blinded low-dose 2D axial and 3D volume rendering images using FBP and ASIR-50, ASIR-100 and MBIR were evaluated by three observers using top-down scoring. By using ASIR-100, radiation dose was reduced by 91% and by 95% of the recommended CTDIvol of sinusitis using MBIR. This may provide similar subjective image quality to a high resolution FBP protocol for guided surgery performed with a dose three times higher than the sinusitis reference level (see Figure 1). Dose reductions were less influential on 3D image quality and ASIR-100 and MBIR may provide similar quality at up to 98% dose reduction (see Figure 2).

Conclusion

Low-dose protocols in modern MSCT may provide substantial dose reductions without significant influence on TRE and should be strongly considered in image-guided surgery. Using iterative reconstructions may significantly improve subjective image quality of ultralow-dose computed tomography imaging of the craniofacial bone.

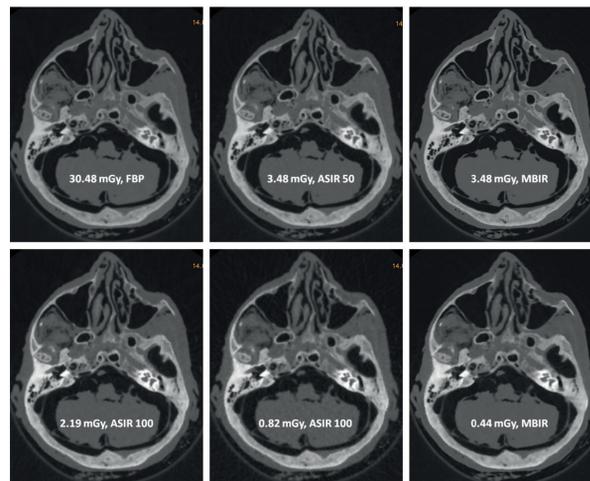


Figure 1: 2D axial images of the FBP high resolution images guided surgery baseline protocol at 30.48 mGy [upper left] and the ultralow dose images with similar score.

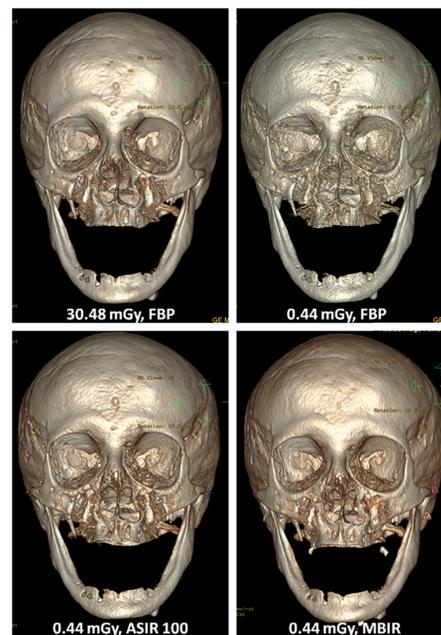


Figure 2: 3D images of the FBP baseline protocol at 30.48 mGy [upper left], and the ultralow-dose images at 0.44 mGy using FBP, ASIR-100 and MBIR.



Figure 3: Bedside chest radiograph with antiscatter grid yields excellent image quality. Image acquisition without antiscatter grid requires substantially less dose. However, image quality and contrast are deteriorated. When applying the scatter correction the image quality is preserved at the same low dose level.

Digital correction of scatter noise to enhance image quality for bedside chest radiographs

Pötter-Lang et al. evaluated the effect of a newly developed processing method which allows for digital correction of scatter noise on image quality for bedside chest radiographs.

Results

For all imaging features, quality was rated significantly different ($p < 0.01$) between the grid images (A; superior) and the uncorrected images (B; worst). Using a score of 4 as the threshold for diagnostically acceptable image quality, there was no difference for three features (non-obscured lung, carina, and venous catheters) between the three modes, but both grid images and scatter-corrected images outperformed the uncorrected images in the delineation of the lower thoracic spine.

Conclusion

The scatter correction algorithm yields significantly higher image quality of bedside chest radiographs as compared to non-corrected images but remained inferior to grid-images. The scatter-corrected images were comparable to grid images based on a threshold chosen to determine potentially diagnostically relevant differences. (see Figure 3) Therefore scatter correction applied to bedside chest radiographs may obviate the need for anti-scatter grids and enables a substantial radiation dose reduction in a patient group requiring frequent radiographs.