Materials and Methods: Two Lanthanum halide scintillation detectors – $LaBr_3$:Ce and $CeBr_3$ were built and tested. The $LaBr_3$:Ce detector has a cylindrical shape. The geometry is optimized for spectroscopy. This detector will be used as an etalon. The $CeBr_3$ detector consists of scintillator with rectangular parallelepiped shape. Many sources were used in this study, covering a range of 20 keV to 1.3 MeV. They were placed in front of the scintillator and the detector was left to count. Energy and efficiency calibrations were performed. Energy resolution as a function of full peak energy was studied.

Results: A very good energy resolution, 4.2% (FWHM) at 121.8 keV is achieved for the $LaBr_3$:Ce scintillation detector. The energy resolution for the $CeBr_3$ detector is obtained to be smaller – 10.8% at the same energy. The thicker $LaBr_3$:Ce detector has a larger efficiency than the $CeBr_3$detector. Also, due to the geometry, the $LaBr_3$:Ce detector has a better peak/background ratio R = 0.21 when compared to the performance of the $CeBr_3$detector R = 0.12.

*Conclusions:*Two scintillation detectors, capable of detecting X- and γ-ray energies, are now being tested in Sofia University within NDeGRA project, funded by the Bulgarian Science fund, contract number DN18/17. Exceptional energy resolution leads to various applications of these detectors mainly in γ-ray spectroscopy. Our very promising results also show that these $LaBr_3$:Ce and $CeBr_3$-detectors can be used in the nuclear medicine, for imaging diagnostics such as PET.

https://doi.org/10.1016/j.ejmp.2019.10.011

Additional step into team approach and optimisation of paediatric patient care and treatment – From CT scan images to 3D models

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Introduction: Segmentation software allow to extract the structures of interest from 3D medical CT imaging data and generate anatomically accurate 3D models. We present how they could be used for optimisation of the routine practice for better representation of paediatric patient's congenital heart malformations (CHM) for pre-operative surgical planning. A team approach is applied between paediatric cardiologist, radiologist, medical physicist, paediatric cardiac surgeons and radiographer, for the development of optimized paediatric clinical protocol.

Methods and materials: An optimised CT angiography (CTA) protocol (80 kV, TCM, 0.828 pitch, 12.5 SD, 0.35 s, 3.3 mGy max$CTDI_{vol}$) was developed on 64-slice CT scanner (Toshiba, Aquilion). Anatomically accurate patient-specific 3D models of CHM were segmented from CTA image data for 10 paediatric patients. 4 patients with Double aortic arch; 1 – Tetralogy of Fallot; 2 – muscular VSDs (ventricular septal defects); 1 – aorto-pulmonary fenestration; 1 – Pulmonary atresia, ventricular septal defect and major aorto-pulmonary collateral arteries (PA, VSD, MAPCAs), 1 – double outlet right ventricle, multiple VSDs, D-malposition of the great arteries (DORV, multiple VSDs, D-MGA).

Results: The 3D models were compared with imaging studies, intraoperative findings and in two cases – PA, VSD, MAPCAs and DORV, multiple VSDs, D-MGA – with the post-mortem specimen. There is a clear overlap between primary imaging, segmented image, printed model and the intra-operative/post-mortem findings and dimensions. This indicates that 3D modelling is an accurate method for representing cardiac anatomy.

Conclusions: 3D segmentation imaging and 3D printing is a useful method which provides in-depth imaging of complex anatomical relations. 3D models are useful in the preoperative preparation and planning of operative strategy. The method is beneficial in cases of complex or rare CHM where conventional imaging is difficult. The method is yet unreliable for assessment of valvular lesions. The implementation of this methodology in the clinical practice benefits form a multidisciplinary approach.

https://doi.org/10.1016/j.ejmp.2019.10.012

Evaluation of SSDE value of a single CBCT OBI patient verification system

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Introduction: The accurate positioning of patient is an essential part of modern radiotherapy. The aim of the study was to investigate and to evaluate the dose from different cone-beam computed tomography (CBCT) scan protocols using size-specific dose estimate (SSDE).

Materials and methods: The study was performed on an OBI 13.5, Varian Medical Systems. Four groups of 20 patients with different anatomy localization were selected. Each group was scanned by one or more of the routine protocols as follows; Pelvic - Pelvis Spot Light (PI) and Pelvis (PII), Lung – Low dose thorax (L-LDTh), Head & Neck – Standard Dose Head (H&N-SD) and Low Dose Thorax (H&N-LDTh), Brain – Low Dose Head (B-LDH), Standard Dose Head (B-SDH) and High Quality Head (B-HQH). Conversion factors were applied in order to calculate the patient's SSDE as a function of the sum of the lateral and AP dimensions, as well as the $CTDI_{vol}$ for the relevant scan protocol. The average SSDE values for each protocol and patient group were calculated.

Results: The analysis of the results showed deviations between 1.3% and 90% depending on the type of localization and protocols. Summary of the observed results for the SSDE values is as follows: PI – 91.1 mGy, PII – 97.2 mGy, L-LDTh – 20.7 mGy, H&N-SD – 33.3 mGy, H&N-LDTh – 33.7 mGy, B-LDH – 7.7 mGy, B-SDH – 15.4 mGy and B-HQH – 77.8 mGy.

Conclusions: Patient positioning verification is an important issue. However, the application of the CBCT systems lead to additional patient exposure. This puts the question for the balance of the frequency of their application and the optimization of radiation therapy process. Proper and optimized application is needed in order to reduce patient exposure.

https://doi.org/10.1016/j.ejmp.2019.10.013

Database dedicated to X-ray breast imaging

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Breast cancer computational models are a key instrument used in the development and optimization of new breast imaging techniques, new realistic test models for X-ray breast dosimetry, as well as reconstruction and image improvement algorithms. This requires the availability in one place of a large number of different breast cancer models and X-ray images from test objects. This work summarizes the types of lesions and X-ray images stored in the MAXIMA database (http://maxima.tu-varna.bg/). The database consists of data and images related to the breast. More specifically, it contains X-ray images from various scientific studies carried with physical phantoms with varying properties and shapes (including anthropomorphic) obtained from different facilities. These include synchrotron