nologies available on one mammography unit: full field digital mammography (FFDM), digital breast tomosynthesis (DBT) and contrast-enhanced spectral mammography (CESM).

Materials and methods: The study was performed on a Senographe Essential/SenoClaire/SenoBright (GE Healthcare) system. The methods recommended in the EUREF protocol were used. Patient data were retrospectively retrieved from PACS with dose tracking software Radimetrics (Bayer). Radiation output and half value layer were measured with X2 (Raysafe) instrument with appropriate calibrations for the spectra used. Incident air kerma (IAK) for patients and PMMA phantom (thicknesses from 20 up to 70 mm with additional spacers) was calculated from the measured data. Mean glandular dose (MGD) was calculated from IAK by applying relevant conversion coefficients.

Results: Data for 74 patients, 296 exposures (FFDM), 82 patients, 172 exposures (DBT), and 43 patients, 148 exposures (CESM) were collected and analysed. MGD varied from 0.87 mGy (FFDM), 1.01 mGy (DBT), 1.82 mGy (CESM) for 20 mm PMMA with 1 mm spacer, up to 2.36 mGy (FFDM), 2.77 mGy (DBT), 3.48 mGy (CESM) for 70 mm PMMA with 20 mm spacer respectively. Mean value of MGD ± standard deviation for the whole patient samples was 1.75 ± 0.72 mGy (FFDM), 1.87 ± 0.65 mGy (DBT), 2.54 ± 0.79 mGy (low energy component of CESM), and 3.16 ± 0.99 mGy (CESM, both energies). MGD from the low energy component of CESM was about 45% higher than MGD from FFDM. MGD from the total CESM exposure taking into account both low and high energy components was 80% and 69% higher than MGD from FFDM and DBT respectively.

Conclusions: Doses from FFDM and DBT are comparable, while from CESM are significantly higher. However, this is considered justified since CESM is used for symptomatic patients.

https://doi.org/10.1016/j.ejmp.2019.10.008

Comparative evaluation of physical breast phantoms dedicated for mammography studies

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Introduction: In the presented paper we provide an evaluation of the properties of physical breast phantoms dedicated to x-ray breast imaging and study. The use of physical phantoms is a widely used approach for evaluation of new breast imaging techniques, control and calibration of imaging equipment and patient dose estimation.

Materials and Methods: The examined phantoms are created through combination of different components, which simulate different elements of the female breast (glandular tree, adipose compartments and skin), and manufactured using various materials (polylactic acid (PLA), Gray resin and Clear resin) and two different methods (fused deposition modelling and stereolithography). The phantoms are evaluated using statistical parameters – namely skewness, kurtosis, fractal analysis, power spectrum analysis (PSA), gray-level co-occurrence matrix contrast and energy, which are compared with the values obtained from real mammograms.

Results: The analysis of images from seven physical phantoms demonstrated that each material has different degrees of resemblance to real breast tissues. The phantoms that achieved results closest to these from real images consisted of PLA, clear resin and glycerol. In particular, the difference between the parameters of the real images and the phantom images is in the range of up to 30% for the best performing materials. Skewness was the parameter where highest differences between real and phantom images were observed.

*Conclusions:*The performed comparative evaluation shows that images, created using the manufactured phantoms have characteristics similar to the real mammograms.

Acknowledgment: This research is supported by the Bulgarian National Science Fund under grant agreement DN17/2.
https://doi.org/10.1016/j.ejmp.2019.10.009

The endotoxin influence on the deformability of red blood cells. (in vitro)

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Experiments with endotoxin is an interesting direction for medical applications. It is known that certain abnormalities in the microcirculation in endotoxin shock are related to a reduction of the surface electrical charge and the deformability of red blood cells. The intravascular coagulation of blood cells or "sludge phenomenon" has been observed in endotoxin and other types of shock. To gain a more comprehensive insight into the effect of endotoxin on erythrocyte membranes an assessment was made of the light dispersion in electric field by erythrocyte suspension. Its adoption enables to investigate better the dynamics of endotoxin interaction with erythrocyte membranes, changes in deformability and the like.

In the latter case the biphasic effect became manifest at the very beginning. It was rather marked in the first minute, while ten minutes later it was no longer noted. The development of intravascular coagulation in shock is related to a lower deformability of the cell membranes.

A decrease of deformability has been established, although only qualitatively. The electro-optical method enables to estimate the quantitative alterations in deformability. From the values of the disorientation time for five of the samples was measured, a 37 percent average reduction of deformability was obtained. It is further more presumed that deformability modification is proportional to the change in relaxation time of disarrangement. This is a mean value of measurements performed during the first minute, when the changes in electro-optical effect are most significant. The reduction of deformability in individual subjects varies in the 30–50 percent range.

Key words: Electro-optical technique, Deformability of red blood cells, Endotoxin shock.
https://doi.org/10.1016/j.ejmp.2019.10.010

Comparative study of Lanthanum halide scintillation detectors

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Introduction: Gamma ray and X-ray detectors are constructed and developed at the Faculty of Physics, Sofia University. They are extensively tested for future use in nuclear physics, astrophysics and nuclear medicine. The aim of this investigation is to perform a comparative study of two scintillation detectors based on Lanthanum halide scintillators - $LaBr_3$:Ce and $CeBr_3$. The study is ongoing. Preliminary results will be presented.

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