

Cardiac Magnetic Resonance Imaging: patient safety considerations

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Abstract

Magnetic Resonance Imaging (MRI) is widely used in medicine. In cardiology, it is used to assess congenital or acquired diseases of the heart and large vessels. Unless proper precautions are taken, it is generally advisable to avoid using this technique in patients with implanted electronic stimulators, such as pacemakers and defibrillators, on account of the potential risk of inducing electrical currents on the endocardial catheters, since these currents might stimulate the heart at a high frequency, thereby triggering dangerous arrhythmias. In addition to providing some basic information on pacemakers, defibrillators and MRI, and on the possible physical phenomena that may produce harmful effects, the present review examines the indications given in the literature, with particular reference to coronary stents, artificial heart valves and implantable cardiac stimulators.

KEYWORDS: Magnetic Resonance Imaging, Coronary Stents, Heart Valves, Implantable Cardiac Stimulators.

Original Paper

Comparison of Uniformity of Dose Response of Double Layer Radiochromic Films (MD-55-2) Measured at 5 Institutions

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Abstract

In recent years, double-layer radiochromic films (MD-55-2), also known as new improved Gafchromic Films (NMD-55), have been used for measuring dose distributions of radiation fields. It is reported that the response of radiochromic film is affected by the scanning densitometry systems used to read the film. To quantify the response of MD-55-2 films, two sheets (12.5 cm × 12.5 cm) from different batches, were irradiated to 900 cGy and 2000 cGy, using uniform flat photon beams. The films were sent to 5 institutions for response evaluation using 5 different densitometry systems with narrow band light source centered at nominal 633 to 665 nm, which is near the major absorption peaks of the film sensitive emulsion. The dose response curve was established for each densitometer. The one-dimensional film responses were obtained for specified directions. A set of fiducial marks, located at ~1.5 cm from the film edges, was used for identification of scan direction and alignment. The local fluctuations were assessed by comparing the film response with the mean response and its relative (percentage) standard deviation (RSD) in the region of interest. The regional non-uniformity was measured by examining the difference between the maximum and minimum responses within the region of interest. Our data indicates that the RSD, as obtained by the 5 institutions, varied from 2.4% to 5.8% for the film irradiated at low (~900 cGy) dose and from 1.2% to 4.3% for the film irradiated at the higher dose (~2000 cGy). The regional non-uniformity was also improved with increased dose and was less in longitudinal direction of the film that is parallel to the direction of coating application. Data comparison for regional non-uniformity indicates that the film responses were affected not only by the wavelength of analyzing source, but also by other instrumentation factors such as step size and sampling size. High-resolution scanners may also have more noise that should not be attributed to film non-uniformity.

KEYWORDS: Radiochromic film dosimetry, Film dosimetry, Dosimetry, Laser scanner.

A massive lesion detection algorithm in mammography

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Abstract

A new algorithm for massive lesion detection in mammography is presented. The algorithm consists in three main steps: 1) reduction of the dimension of the image to be processed through the identification of regions of interest (ROI) as candidates for massive lesions; 2) characterization of the ROI by means of suitable feature extraction; 3) pattern classification through supervised neural networks.

Suspect regions are detected by searching for local maxima of the pixel grey level intensity. A ring of increasing radius, centered on a maximum, is considered until the mean intensity in the ring decreases to a defined fraction of the maximum. The ROIs thus obtained are described by average, variance, skewness and kurtosis of the intensity distributions at different fractions of the radius. A neural network approach is adopted to classify suspect pathological and healthy pattern.

The software has been designed in the framework of the INFN (Istituto Nazionale Fisica Nucleare) research project GPCALMA (Grid Platform for CALMA) which recruits physicists and radiologists from different Italian Research Institutions and hospitals to develop software for breast cancer detection.

KEYWORDS: Mammography, Neural Networks, CAD (Computer Aid Detection).

Experimental method to obtain scattering contribution in portal dose images

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Abstract

A method for evaluating scattered dose contribution in portal images acquired under clinical conditions (phantom-device distance of 30 cm) is presented. This method is based on radiographic film and ionisation chamber measurements and is valid for homogeneous polystyrene phantoms and square fields of different size. The portal imaging device consisted of a radiographic film placed between slabs of polystyrene under full build-up conditions (1.5 cm for 6 mV beam and 3 cm for 18 mV) and 1 cm of polystyrene backscatter material. First the primary dose image in the portal plane $P(i,j)$ is obtained using a projection algorithm, then the scattered dose image $S(i,j)$ is found by subtracting the primary dose image in the portal plane $P(i,j)$ from the total dose image acquired in the portal plane $T(i,j)$. The ratio $S(i,j)/T$ between the scattered dose distribution and the dose value measured on the beam axis in the portal plane was found to be uniform within the radiation field for all the geometrical configurations of phantoms and fields studied. Under these conditions the mean value of the scatter fraction S/T evaluated within a ROI centred on the beam axis accurately describes the scatter fraction distribution $S(i,j)/T$ within the whole radiation field. S/T ranges from 7.4% to 31.4% in the 6 mV beam and from 8.9% to 30.8% in the 18 mV beam. Finally an analytical method to evaluate the ratio S/T has been developed from the experimental results. It comprises phantom, accelerator head and portal imaging device contributions and depends on field size and phantom thickness.

KEYWORDS: Portal dosimetry, Scattered radiation, EPID, Portal imaging.

A new method based on contact surface profilometry for quantitative measurement of resorbed bone volume

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Abstract

Bone is a dynamic tissue. Its continuous remodeling depends on the balance between bone formation and bone resorption. These two processes are carried out by specialized cells called osteoblast and osteoclast respectively. The osteoclastic bone resorption consists in degradation of the mineral and collagen components of bone.

The study of bone turnover requires accurate assessment of osteoclastic bone resorption, that becomes even more important in pathologic bone loss due to the uncoupling between bone formation and bone resorption. Osteoclastic activity is difficult to measure. Many techniques, generally based on the detection of the resorbing lacunae (pits) due to the bone degradation, allow to estimate bone resorption, but none of them quantitatively and directly measures the volume of resorbed bone.

We propose a reliable and relatively simple method, based on contact surface profilometry, to evaluate directly and quantitatively the volume of resorbed bone. The method has the following advantages:

- i. to perform a comparison of the same bone surface before and after the exposure to the osteoclastic activity;
- ii. to enhance the sensitivity by utilization of bone slices shaped and polished in order to concentrate the cell activity in a controlled area.

KEYWORDS: Surface profilometry, bone resorption.

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