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Building materials as a source of population exposure to ionising radiation

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Abstract

After a review of international literature on building materials as a source of gamma irradiation and on surveys of indoor and outdoor dose rate, some experimental difficulties in gamma spectrometry of natural radionuclide spectra in laboratory are discussed and the utility of gamma spectrometry *in situ* is presented. Finally, the way of assessing effective doses originated by building materials is analysed.

KEYWORDS: Radioactivity, building materials, population exposure.

Magnetic map analysis during ventricular repolarization to differentiate between normal subjects and patients affected by cardiac hypertrophy

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Abstract

Abnormalities in the repolarization phase can play a major role in many cardiac diseases. Because of the low frequency components of signals during the ST-T segment of the ECG, classical methods performing frequency domain analysis are not effective. The aim of this study is to use magnetocardiography (MCG) to perform both descriptive and quantitative analysis of the cardiac signal during the ST-T segment in a test group of patients affected by repolarization abnormalities -not revealed with conventional ECG- which were related to cardiac hypertrophy, and to compare these results with those obtained applying the same analysis to a control group. Unfiltered data are used for descriptive analysis, and the trend of two parameters during the repolarization phase is estimated: the average intensity of the magnetic field (factor Q) and a map quality index (MI) representing the stability of the magnetic field. Filtered data are used for quantitative analysis which consists in the computation of indexes based on the correlation coefficients between subsequent magnetic maps (Relative Smoothness Index - RSI). This index is able to quantify the instability of the magnetic field during the repolarization phase. Different band-pass filters are tested in order to verify which band-pass, if any, allows a better differentiation between patients and normal subjects. Both descriptive and quantitative analysis allow a good separation between patients and normal subjects. The best results are obtained with the quantitative method in combination with the use of either the 7-150 Hz band-pass filter or 15-150 Hz band-pass filter. In both cases patients can be distinguished from normal subjects at a significance level $p < 0.01$. Our results suggest that an appropriate analysis of the magnetic signals might help in clinical practice to differentiate between normal and pathological conditions even in cases in which classical ECG exams do not detect any evidence for repolarization abnormalities.

KEYWORDS: Magnetocardiography, ST-T segment, statistical analysis, map analysis.

Evaluation of Recalcification of Bone Metastases after Radiotherapy and I.V. Infusion of Disodium Pamidronate, Using Image Processing Techniques. Comparative Assessment Using Measurements of the Optical Density of Plain Radiography*

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Abstract

The aim of the study was to radiographically monitor the early effect of radiotherapy in conjunction with Disodium Pamidronate (DP), on metastatic bone disease, using image-processing techniques. Eight patients with bone lytic metastasis received radiotherapy with a 6MV linac up to a dose of 30Gy (3Gy per fraction, 5 days a week) combined with 6 monthly sessions of infusional 180mg of DP. Conventional X-rays of all patients were obtained at every session of the treatment, retaining the same settings for each exposure. Quality assurance of accuracy and precision of X-ray exposure parameters showed acceptable values. The analysis of the image attributes was based on measuring the first order statistics of the gray level histogram such as mean value (MVGLH) and energy (EGLH), in 24 small rectangular areas constituting the region of lytic metastasis. The measurements showed a 35.72 % reduction of EGLH and a 3.17% increase of MVGLH, before and after the combined treatment. Further analysis concerning the measurement of the optical density of the film in the region of lytic metastases at every session of the treatment revealed a reduction up to 29.12% ($P < 0.001$, Kruskal-Wallis test). The changes in the MVGLH were high correlated with the changes of EGLH in terms of $R_s = 0.98$ ($P < 0.0001$, spearman's-rho test) and furthermore with the changes in optical density in terms of $R_s = 0.87$ ($P < 0.0001$, spearman's-rho test). These findings indicate a significant level of reliability for both of the above-mentioned methods and beyond this, an important objective early increase in bone mass and formation, which was difficult to be identified visually by the experts.

KEYWORDS: Image processing, optical densitometry, bone metastasis, radiotherapy and disodium pamidronate.

Evaluation of the accuracy of a surface fitting based registration between ²⁰¹Tl-SPECT and MR images in brain tumor studies

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Abstract

Correlation between ²⁰¹Tl-SPECT and MRI images improves their diagnostic potential in intracranial tumors. The aim of this work was to assess the accuracy of the algorithm for use in clinical procedures. Our investigations have adopted three different paths: a) with a 'digital phantom' to look into the intrinsic limits of the algorithm; b) with a geometric phantom to point out the effective registration errors of intracranial lesions; and c) with 11 patients, placing fiducial markers on the subjects' scalps to quantify correlation accuracy.

The use of the digital phantom has shown a clear difficulty of the algorithm in recognizing the rotation out-of-plane about X or Y-axes. For the patients where there was not a significant tilt between the X-Y SPECT and MRI planes, the match was successful. On average, a mean distance between corresponding markers of 5.54 ± 0.46 mm was measured that, as shown by verification with the geometric phantom, overestimates the local errors inside the brain. In our opinion, surface matching can be used in clinical routine with a visual validation, based on fiducial anatomic features (the scalp), provided that significant rotations about the X or Y-axes are avoided or pre-corrected.

KEYWORDS: Image fusion; brain tumor; SPECT; MRI.