Shielding of Multi-Detector CT rooms : comparison of DIN, NCRP and BIR approaches

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Introduction

When designing the proper shielding of a CT room, the accurate determination of the spatial distribution of scattered radiation is necessary and various models have been proposed and of particular interest are the models proposed by the US National Council on Radiation Protection and Measurements (NCRP)[1], the German Institute for Standardization (DIN)[2] and the British Institute of Radiology and Institute of Physics in Engineering in Medicine (BIR-IPEM)[3]. The aim of this work is to compare the DIN model (thus the formalism used in Switzerland) with the NCRP and BIR-IPEM models, to investigate the limits of using the tube loading in mA.min as the working parameter for new CT units and to explore the appropriateness of using the DLP instead

Material and Methods

Dose measurements were performed on a 64-detector row CT system (VCT, GEMS, Milwaukee, WI) at the Lausanne University Hospital (CHUV). Two CTDI test objects (∅32 cm and ∅16) were scanned in helical mode. The ambient dose equivalent, H*(10), was measured at various distances from the isocenter of the CT unit at various angles to establish an isodose cartography. Following this experiment, ten sets of thermoluminescent dosimeters (LiF 100 TDLs) were placed for two weeks at various positions in the three rooms where a CT is present (two CT units used for elective examinations (a 64-detector row and 8-detector row CT system (respectively Lightspeed and VCT from GEMS) and one CT used for emergency situations running 24 hours a day, a 64-detector row CT system VCT, GEMS) in order to measure the ambient dose delivered in a two-week period representing the normal use of the CT units.

Results

The NCRP model differs from the DIN model by a factor of about five leading to a large overestimation of the shielding estimation when using the DIN approach.

Discussion

In Switzerland, the tube loading needed for a CT slice, expressed in mA.min, for a given anatomical region to be examined is used to establish the dose of scattered radiation and thus to design the necessary shielding of a CT installation. If this method was already questionable for single-detector row computed tomography with sequential scanning (inadequate beam quality and tube leaking values), it becomes even more problematic with the introduction of spiral mode acquisition, since with a volume scanning as many slices as desired can be reconstructed. With the steady increase of the X-ray beam collimation width in modern CT units, the current method needs to be replaced with a more robust one in order to assure sufficient shielding. The DLP should be used since it leads to results independent of the collimation and the high voltage, and which depend only on the size of the scanned object.

References

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