World Academy of Science, Engineering and Technology
International Journal of Health and Medical Engineering
Vol:10, No:07, 2016

Characterization of the MOSkin Dosimeter for Accumulated Dose Assessment in Computed Tomography

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Abstract : With the increase of beam widths and the advent of multiple-slice and helical scanners, concerns related to the current dose measurement protocols and instrumentation in computed tomography (CT) have arisen. The current methodology of dose evaluation, which is based on the measurement of the integral of a single slice dose profile using a 100 mm long cylinder ionization chamber (Ca,100 and CPPMA, 100), has been shown to be inadequate for wide beams as it does not collect enough of the scatter-tails to make an accurate measurement. In addition, a long ionization chamber does not offer a good representation of the dose profile when tube current modulation is used. An alternative approach has been suggested by translating smaller detectors through the beam plane and assessing the accumulated dose trough the integral of the dose profile, which can be done for any arbitrary length in phantoms or in the air. For this purpose, a MOSFET dosimeter of small dosimetric volume was used. One of its recently designed versions is known as the MOSkin, which is developed by the Centre for Medical Radiation Physics at the University of Wollongong, and measures the radiation dose at a water equivalent depth of 0.07 mm, allowing the evaluation of skin dose when placed at the surface, or internal point doses when placed within a phantom. Thus, the aim of this research was to characterize the response of the MOSkin dosimeter for X-ray CT beams and to evaluate its application for the accumulated dose assessment. Initially, tests using an industrial x-ray unit were carried out at the Laboratory of Ionization Radiation Metrology (LMRI) of Federal University of Pernambuco, in order to investigate the sensitivity, energy dependence, angular dependence, and reproducibility of the dose response for the device for the standard radiation qualities RQT 8, RQT 9 and RQT 10. Finally, the MOSkin was used for the accumulated dose evaluation of scans using a Philips Brilliance 6 CT unit, with comparisons made between the CPPMA,100 value assessed with a pencil ionization chamber (PTW Freiburg TW 30009). Both dosimeters were placed in the center of a PMMA head phantom (diameter of 16 cm) and exposed in the axial mode with collimation of 9 mm, 250 mAs and 120 kV. The results have shown that the MOSkin response was linear with doses in the CT range and reproducible (98.52%). The sensitivity for a single MOSkin in mV/cGy was as follows: 9.208, 7.691 and 6.723 for the RQT 8, RQT 9 and RQT 10 beams qualities respectively. The energy dependence varied up to a factor of ±1.19 among those energies and angular dependence was not greater than 7.78% within the angle range from 0 to 90 degrees. The accumulated dose and the CPMMA, 100 value were 3,97 and 3,79 cGy respectively, which were statistically equivalent within the 95% confidence level. The MOSkin was shown to be a good alternative for CT dose profile measurements and more than adequate to provide accumulated dose assessments for CT procedures.

Keywords : computed tomography dosimetry, MOSFET, MOSkin, semiconductor dosimetry
Conference Title : ICRSD 2016 : International Conference on Radiation Science and Dosimetry
Conference Location : London, United Kingdom
Conference Dates : July 28-29, 2016