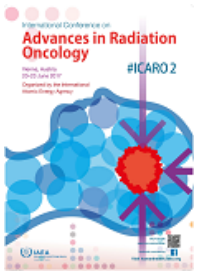

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Empirical model for phantom scatter for small beam dosimetry in different density media

Thursday 22 June 2017 15:40 (5 minutes)

Purpose: phantom scatter, Sp, is an important factor needed to calculate dose in media. It is affected by small beam dosimetry, in a similar way as collimator scatter, Sc, with the added layer of media (density) effect. Our work is geared towards finding a simple model for calculating Sp for small beams in various media. The results were verified by comparing calculated Sp vs measured Sp in an anthropomorphic phantom.

Materials/method: Various size chambers were used to measure the total scatter factor, Scp, and the collimator scatter, Sc, for MLC-shaped square fields with sides (r) 0.49 to 10 cm using Elekta's Apex® collimator. Three different cube phantoms were constructed from solid water, wood and plastic. An anthropomorphic phantom representing the thoracic region was CT-scanned. Four points in three regions, mediastinum, lung (central and peripheral points) and spinal cord, were irradiated with various beam geometries, AP, PA and Lat. From the measured dose, Sp for each point was calculated and then compared with our predicted value.

Results: A term called the output factor ratio (OFR) defined as (S_(p_medium) (r))(S_(p_water) (r)) was created. OFR was plotted against chamber size and a linear curve was obtained, Fig1. The extrapolation gives the OFR value independent of detector size for every r. Another relation was constructed by plotting OFR vs field size and normalizing each value to that of water, Fig2. This is used to relate Sp for small r with that of large r. Fig 2 shows that OFR values are straight and matching that of water within +5% until very small beams where it slightly curves upward for low density medium or downward for high density medium. An exponential function was used to fit this behavior in the form 〖OFR〗_w^m=Q+Pe^(-Kr), where Q, P and K are fitting parameters. Sp can then be calculated for any beam size using values measured for broad beam geometries. Table 1 compares measured vs calculated Sp values in various tissue composition for various beam entry. Sp for the phantom was measured by dividing the dose in air (with buildup) to the dose in the phantom at that point for the same SSD, MU and beam. Various entries of radiation was used to change the composition and layers of tissue that the beam goes through before it reaches the point. The measured Sp has, as expected, different values for each location/beam entry, whereas our model only predicts one value per tissue composition, the calculated Sp was within 3% of Sp measured in 8/12 cases, within 5% in 2/12 cases, and within 8% in 2/12 cases, Table 1.

Conclusion: Our model calculating Sp for small beams and in various media successfully predicted Sp values to within 5% from measured values in (10/12) combinations of beam-entry and location inside the anthropomorphic phantom. Improvement on the model requires taking into account the layers of heterogeneities surrounding the point to increase accuracy of Sp values that are sensitive to surrounding tissue.

Country

Saudi Arabia

Institution

King Faisal Specialist Hospital and Research Center

Author: WADI-RAMAHI, Shada (King Faisal Specialist Hospital and Research Center)

Co-authors: ATTAWNEH, Saad (King Hussein Cancer Center); DABABNEH, Saed (Al Balqa Applied University)

Presenter: ATTAWNEH, Saad (King Hussein Cancer Center)

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