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Evaluation of Al_2O_3:C OSL dosimeters for use in dose distribution verification of VMAT planning simulation

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The Volumetric Modulated Arc Therapy (VMAT) is an advanced technique of Intensity Modulated Radiation Therapy (IMRT). This progress is due to the continuous gantry rotation with the radiation beam modulation using multileaf collimators (MLCs). If compared with IMRT, the VMAT provides a lower toxicity in the patient's treatment, higher dose intensity at the target volume and preserving most of the regions of healthy tissue around the tumor. This new radiotherapy technique also provides a reduction in the irradiation time during treatment and a smaller number of monitor units (MU). Therefore, the VMAT is shown as a safer, accurate and faster technique during the patient's treatment. This paper aimed to verify the dose distribution through the analysis of the isodoses curves of two planning treatment simulations using the Al_2O_3:C dosimeters and optically stimulated luminescence (OSL) dosimetry technique.

Al_2O_3:C samples from Rexon TLD System and a TL/OSL RISO Reader, model TL/OSL-DA-20, were used to OSL measures. The dosimeters characterization, sensitivity, repeatability and dose response curve, using clinical photons of 6 MV was performed using PMMA plates of 30x30x30 cm^3 with different thickness to guarantee the maximum dose depth. All irradiations were carried out using a Truebeam STx linear accelerator (RapidArc) of the Hospital Israelita Albert Einstein. A specific PMMA phantom containing five cavities with different geometries, that can simulate the organs involved in the planning simulation was developed to the VMAT irradiations. Two planning treatment simulations were proposed: in the first planning simulation no isodose curves pass through the five cavities, thus, the doses are homogeneous into the five cavities; in the second planning simulation the phantom was used to simulate a vertebra treatment with spinal cord protection, in this case, there are isodoses curves passing through the cavities as provided by planning system. The OSL dosimeters were irradiated positioned in the phantoms' cavities according to the two planning simulations. The results obtained with the OSL dosimeters were compared with the results given by the Eclipse 11.0 planning system.

OSL responses showed repeatability better than ±3%. The dose response curves present linear behavior in the dose range studied between 0.1 and 10 Gy. The dose distribution in the two planning simulations in the cavity that simulated the tumor and the risk organs were clearly identified and are better than ±1% and ±7.5%, respectively, according to the data given by the planning system. In the second simulation it can be observed that in some cavities there are more than one isodose curve passing through and as a consequence there are greater variations in the absorbed dose, as expected.

The evaluation of the dose distribution is very important to the quality control of VMAT equipment and patient treatment planning and the obtained results indicate that Al_2O_3:C OSL dosimeters can be useful for quality control of VMAT equipment.

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