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Aplication of Optically Stimulated Luminescence 'dot' dosimeters for dose verification of VMAT treatment planning using an antropomorfic stereotactic End-to-End verification phantom

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Radiotherapy uses ionizing radiation for malignancies treatments and seeks the extermination of tumor volume, exclusively or associated with other therapies and a quality assurance program must be established by evaluating, among other items, the dosimetric factors. Studies using aluminum oxide (Al_2O_3:C) OSL dosimeters for high-energy radiation photon beams analysis has been accomplished, however the number of published papers is small and the lack of established protocols remain the main obstacle for its popularization in clinical dosimetry. Most of the documented experiences in this field of clinical dosimetry were performed using lithium fluoride (LiF:Mg,Ti) and Calcium Sulfate ($CaSO_4$:Dy) TL dosimeters. The aim of this work is to evaluate the performance of the commercial *Landauer InLight™ System* to be applied in dosimetric measurements in a Volumetric Modulated Arc (VMAT) brain tumor treatment using a *Stereotactic End-To-End Verification Phantom* (*STEEV*™ - CIRS), comparing its results with $CaSO_4$:Dy TLD pellets manufactured and marketed by the Laboratory of Dosimetric Materials/IPEN, PTW *PinPoint™3D* ion chamber and Eclipse 10.0 planning system.

The *InLight™ System* microStar reader, nanoDot dosimeters (supplied by SAPRA Landauer), and the $CaSO_4$:Dy TLD pellets(1) were formerly tested in the Instruments Calibration Laboratory of Radiation Metrology Center - IPEN to a standard reference response of 1.25MeV energy ^{60}Co gamma source (0.339 TBq ±3.5% in September/1999) with kerma rate of 0.276 mGy/s (±2%) and 12.5x12.5cm² field for preliminary dosimetric characterization and its repeatability and stability evaluation. In addition, both types of dosimetric materials were calibrated for 6MV photon beam, in a VARIAN™ NOVALIS TX Linear Accelerator at Sírio-Libanês Hospital, and all results were corrected by absolute wather dosimetry. A brain tumor VMAT treatment was planned and delivered to *STEEV™ Phantom Patient.* The process was repeated 5 times using $CaSO_4$:Dy TLD pellets, nanoDot dosimeters and PTW *PinPoint™3D* ion chamber separately.

For laboratory and clinical dosimetric characterizations, both types of dosimeters presented linear behavior to the dose range studied (from 50 to 300cGy), good reproducibility and stability (±1.5%). The dose values obtained checking the calibration curves, control doses before phantom irradiations and for prescribed target dose planned had total uncertainties about ±1.5% for nanoDot dosimeters, ±1.0% for *PinPoint™3D* ion chamber, lower then ±3.5% for $CaSO_4$:Dy and all results met with Eclipse 10.0 planed treatment.

The results of commercial *InLight™ System* using the *nanoDot* dosimeters showed that OSL dot dosimeters had good reproducibility and stability in both laboratory and clinical measurements. The $CaSO_4$:Dy TLDs, as predicted, presented good performance as well, and all results met with ion chamber data and Eclipse prescribed doses. All the results had uncertainties better then ±3.5%, so the repeatability of TL and OSL was within acceptable limits for radiotherapy purposes. In addition, due to its versatility, the *InLight™ System* can be applied as a tool for dose verification in VMAT planning treatments and met the performance requirements of ICRU(2) and AAPM(3).

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(2) INTERNATIONAL COMISSION ON RADIATION UNITS AND MEASUREMENTS - ICRU. Report 24: *Determination of Absorbed Dose in a Patient Irradiated by Beams of X or Gamma Rays in Radiotherapy Procedures*. Bethesda, Maryland: ICRU Publications, 1976.
(3) AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE - AAPM. TG 21: *A protocol for the Determination of absorbed dose from high-energy photon and electron beams*. Medical Physics. 10(6), 741-771. 1983.